SPICES
AND HOW TO KNOW THEM

By W. M. GIBBS

A NATIVE OF JAMAICA ISLAND

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MCMIX

COMPOSITION, PRESSWORK, AND
BINDING
BY THE MATTHEWS-NORTHRUP WORKS
BUFFALO, N. Y.

TO THE PROGRESSIVE PLANTER AND HONEST MILLER OF SPICES, TO THE SCRUPULOUS AND CONSCIENTIOUS WHOLESALE AND RETAIL DEALER, TO THE EARNEST COMMERCIAL MAN, AND TO THE CONSUMER WHO IS PARTICULAR: THIS BOOK IS RESPECTFULLY DEDICATED.

CONTENTS

INTRODUCTION

IT is with a certain feeling of helplessness and loneliness that I am venturing upon the attempt to trace out the history of spices, as I have not a spice grove or garden to step into for my information; but I must depend upon a far-distant country, where intelligence is but little above what it was five hundred years ago, where may be found the lair of the lion and the jungles of the tiger, where the elephant is used as a beast of burden, where the people file their teeth and color them black because they think natural white teeth too much like dogs' teeth. The fact that such ignorance is general in the Spice Islands obviously makes my information the more difficult to obtain. Moreover, the camera and its uses are not known among the Malays, and the painter's art is not among their imaginings. For these reasons, the illustrations I have obtained have been secured only at great cost, but they are as true to nature in color as it is possible for printer's ink to make them. I hope they will aid me in realizing my purpose of making dealers in spices more familiar with their goods.

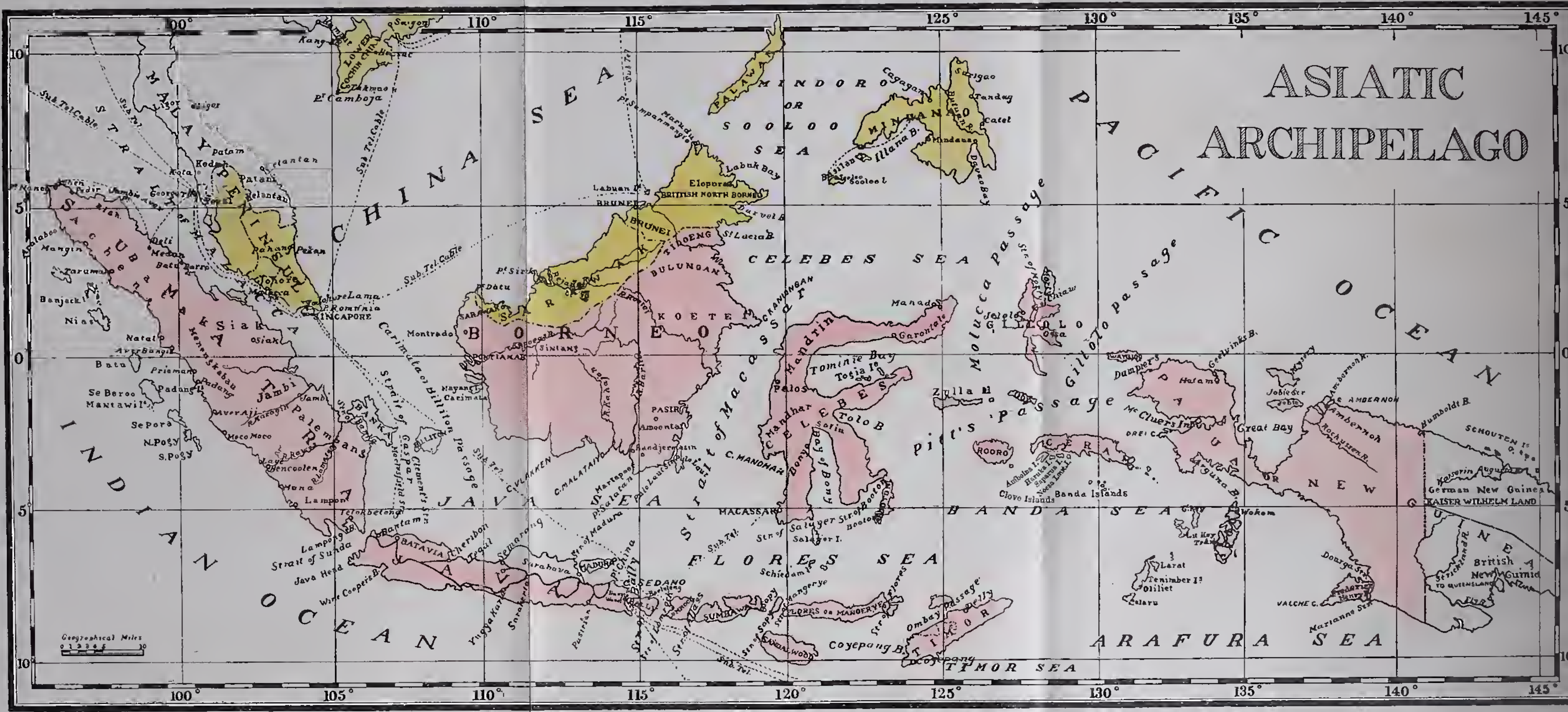
It was not until after long and careful consideration of the fact that the mass of people know but little about the condiments which are to be found on almost every table, and of the further fact of the "inhumanity of man to man" in adulterating, that I was bold enough to attempt to write upon a subject never before written upon, except in a meager way. And although I do not expect to interest all who may read my pages, I hope to create a wish in some to know more of the flavors which so tickle the palate, the fruits of that far-distant country, the Straits Settlement, and neighboring regions.

If I succeed in creating a desire among the retail dealers in spices to know the goods better, and to sell only those which are pure and wholesome, I shall feel that my work has not been a failure. In placing the

same before the public, I believe it to be the most complete work ever written upon the subject with which it deals.

THE AUTHOR.

I am much indebted to the United States Department of Agriculture, Bulletin 13, by Clifford Richardson, for information in Chapter 3, on Adulterations and Analysis of Spices. Also to the United States Consulates of the cities of Penang, Singapore, and Colombo, to whom I extend thanks.


ASIATIC
ARCHIPELAGO
CHINA SEA
PACIFIC OCEAN
INDIAN OCEAN
JAVA SEA
FLORES SEA
BANDA SEA
ARAFURA SEA
TIMOR SEA
CELEBES SEA
SOOLOO SEA
MINDORO OR
BORNEO
BRITISH NORTH BORNEO
SARAWAK
BRUNEI
MINDANAO
PALAWAN
CELEBES
GILLOLO
TIMOR
SUMATRA
MALAY PENINSULA
LOWER COCHIN CHINA
Strait of Macassar
Molucca passage
Gillolo passage
Pitt's passage
Strait of Sunda
Strait of Malacca
Karimata Passage
Strait of Gaspar
Tominie Bay
Bay of Bony
Geelvink B.
German New Guinea
KAISER WILHELM LAND
British New Guinea
Great Bay
Banda Islands
Tenimber I^s
Larat
Coyepang B.
Macassar
Manado
Pasir
Singapore
Batavia
Surabaya
Montrado
Sub. Tel. Cable
Geographical Miles
100°
105°
110°
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120°
125°
130°
135°
140°
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CHAPTER I.

EARLY HISTORY OF SPICES

"Be still! oh North winds, and come, oh Southern breezes, and blow upon my garden, that the spice trees therein may blossom and bear fruit!"

"His cheeks are as a bed of spices, of sweet flowers."

—*The Song of Solomon.*

THE terms spices and condiments are applied to those articles which, while possessing in themselves no nutritious principles, are added to food to make it more palatable and to stimulate digestion. They are of an exclusively vegetable origin, and occupy an important position in the diet of the human race.

A ride of thirty-five days by ocean steamer from New York City brings us to the city of Singapore, situated on a small island of that name, the principal exporting city and the metropolis and capital of Malaysia, the Straits Settlement, India. The islands that constitute the Straits Settlement are crowned with spice forests. Here the noonday sun is truly vertical twice each year, and for many days it passes so near the zenith that change is scarcely perceptible. Here the grand constellation Orion passes overhead, while the Great Bear and Pole Star lie low down in the horizon. To the south may be seen the Southern Cross, and the planets high in the zenith.

No autumn tints, like those of our Northern woods, deck the spice forests. There is no purple and yellow dying foliage which rivals, and even excels, the expiring dolphin in splendor, and the long, cold sleep of winter and the first gentle touch of spring are unknown. But instead, we behold a ceaseless round of active life, which weaves the fair scenery of the tropics into one monotonous whole, the component parts of which exhibit in detail untold variety and beauty; and no one component part impresses us more forcibly than the spice trees. It is said that sailors, several miles at sea, in favorable

weather, with a gentle land breeze, can tell they are nearing land long before they come in sight of the islands by the fragrance of the spice gardens.

Singapore has a population of only 200,000, and the small island on which it is built contains but 145,000 acres, yet the city does a business of $200,000,000 a year and can count its millionaires by the score. Eighty years ago, the place where it stands was simply a jungle for tigers.

Singapore has ships from every port of the world going in and out of its harbor, and its streets are as lively as those of New York. You can go from it to the continent in a rowboat in one-half hour. Close connections are also made at Singapore for Siam, Borneo, Australia, China, Japan, Sumatra, and Ceylon, and it is the half-way station of the voyage around the world.

The Island of Ceylon, with Colombo as its capital and chief city of export, also produces many fine spices. What could India do without her Spice Forests? This is a question which remains unanswered. We might as well ask what the United States could do without its wheat fields.

The different grades of spices take their names from the country or city from which they are exported, each different kind having a flavor of its own. Our best grades come mostly from Penang, and are called "Penang Spice," while spice of nearly as good a quality comes from parts of Malabar. Other chief cities of export are Bombay, Batavia, Calcutta, and Cayenne, South America; but the most important is Singapore, as has been before mentioned.

The declared value of all spices shipped direct to this country averages about $12,000,000 worth annually. Among the cities that import spices New York stands first, probably receiving more than three-quarters of all importations. In 1898, 5,000,000 pounds of ginger were received at New York — 19,000 bags being from Calcutta, 9,010 from Africa, 65,000 from Cochin, 3,608 barrels from Jamaica. There were 6,000,000 pounds of pepper received at New York, and probably nearly as much more at other ports. This may seem a large

A PLANTATION ON JAMAICA ISLAND

A PLANTATION IN INDIA

amount, but when we consider the quantity used in prepared meats and pickles, and the fact that pepper is on every table which can afford a pepper-box or caster, and that pepper enters into some of our food at nearly every meal, the above amount, which gives less than one-sixth of a pound per capita, is not large. A larger sum is paid for pepper than for any other spice. The amount paid for spices in this country annually does not fall much short of one dollar per capita at retail prices.

Four and one-half days by ocean steamer from New York brings us to the Island of Jamaica; and this chapter would not be complete if I did not mention that gem of the West Indies, the home of the Pimento and the famous Jamaica Ginger. Xaymaca (the Indian name for Jamaica) is like a huge mountain standing alone in the Carribean Sea, with its hard, white coral beach and ideal climate. The ride from Kingston, the capital of the island, with its 50,000 population of picturesque folks (Americans, Europeans, West Indies women, gorgeously arrayed, and the coolie women loaded with ornaments), to beautiful Montego Bay and Port Antonio is an experience never to be forgotten.

CHAPTER II.

ADULTERATION OF SPICES

THE Dutch at one time tried to control much of the spice trade but were frustrated by the birds which carried the seeds and planted them in other countries. We are strongly inclined to look upon the scheming Dutchman with contempt for this selfish act, but there is to-day hovering over spice products a greater evil, which makes one feel almost like shedding tears of shame for the acts of men who adulterate spices. If they would stop in their work long enough to ponder on the following appropriate words, they might receive new light in their attempt to mock Nature:

"Thou great first cause, and only cause direct,
All else existing, only in effect;
Cause and effect must harmonize and blend,
To doubt the cause, we need but doubt the end.

Perfection altered, would produce a flaw.
God cannot err, hence, cannot change His law.
First, follow Nature, and your judgment frame
By her just standard which is still the same.

Unerring Nature, still divinely bright,
One clear, unchanged and universal light.
Life, force, and beauty must all impart;
At once the source, and end, the test of Art."

When the spice grinder will consider how hard it is to hide the spark of Nature, whoever yields reward to him who seeks and loves her best, and when the retail dealer of spices will remember that there is another man on the other side of the counter who is entitled to his money's worth, then, and not until then, will the evil of the adulteration of spices be done away with.

A merchant who will, knowingly, sell to his customer adulterated spices at the value of pure goods is worse than a thief, because he not only robs them of their money but gives them poison for their stomach.

Spice millers should not be counterfeiters! How can they afford to imperil their reputation by advertising "seheme goods"? Let them grind their spices to give Nature's flavors as they grow in the balmy forests of the East Indies. Let them not mix these spices to suit the price of the retail dealer, but grind them pure, to please the tongue and the palate, and then hang out their sign, as their business would suggest, as spiee millers or grinders, instead of "spice manufacturers." If the retail dealer of adulterated spices trusts a customer who will not pay his indebtedness, he calls the man a rogue, but forgets that the greater rogue is himself; that his customer has the law on his side, and that his best witness is the adulterated goods whieh were sold him; furthermore, this dealer is teaching to the clerk whom he has taken into his employ, with a promise to teaeh the young man the trade and good business prineiples of an honest merchant, the trade of a thief, and as sueh teaches him to rob his employer. If the merchant breaks his part of the contract, can he expect the elerk to keep his? If the clerk, trained by the dealer in dishonesty, steals from the cash-drawer, would it be right to diseharge him with a tarnish on the good name he had when he entered sueh employ? Let the dealer keep pure goods, and teach his clerk their merit. By so doing, he can be twiee armed when he is selling in competition with a dealer of adulterations.

Let not the merchant profess to seek after the prosperity of the eountry; let him wonder not that business is dull; that labor is unemployed; that enterprise is dead, when hc is doing all he can to destroy business and eommercial prosperity by undermining the public eonfidence, which is the foundation upon whieh all commereial enterprise rests. Nothing is more essential to business prosperity than a eonfidence that prosperous, existing eonditions will remain unehanged. He who is helping to destroy that confidence makes himself a stumbling block in the publie highway of humanity and, as sueh, is a detriment to mankind. He is the greatest enemy to self that humanity ean produee. He

is like a vine which climbs the tree and obtains its life by sucking the life of that to which it clings.

No man can be a good citizen who will wrong his fellow man simply because the laws of the country will protect him or, in other words, will not punish him for such wrongdoing. A miller or retail dealer of mixed or adulterated spices is as much a criminal as the man who has ingenuity enough to shape a coin from alloy and stamp it as a legal standard, or as one who counterfeits a bank note, for all are guilty of illegal acts to obtain wealth. The government punishes the counterfeiter of money, but the dealer in adulterated goods is allowed freedom. The government will grant a patent for the latest improvement in machinery for mixing spices, but it will not grant a patent for a die to counterfeit bank notes.

The dealing in adulterations is not confined to the poorer dealers. Among those who are guilty of this wrong we find the wealthy and those professing to be Christians — men who shudder at a dishonest act, but they apparently forget their duty to God and man. Is not such conduct mockery? Is it not offensive to God? If not, where could we find that which would be? Let men dare to do right if they wish to be successful and respected. Let them dare to do right for the sake of their fellow man who is striving for an honest living. Let them dare to do right and not wait for the law to compel them. Let them remember that there is something in an honest name which they cannot afford to lose!

To the consumer of spices, this should be said: Be willing your grocer should live and obtain a profit for his work. Do not compel him to handle adulterated goods by quoting him the price of his neighbor dealer who sells the adulterated stock. Spices of high order are more costly, but are cheap to the consumer by reason of excess of flavor and strength. Let your dealer know you can appreciate a good article and, if he handles adulterated goods, remind him "that he may fool all the people some of the time, and some of the people all of the time, but he can't fool all of the people all of the time."

*As an illustration of the extent of the adulteration of spices, the fact may be cited that one firm in New York City used and put upon the market in their spices more than 5,000 pounds of cocoanut shells. To show how bold the custom has become, the following quotation is copied from a journal devoted to spices:

"All necessary information for spice manufacturing supplied."

And the following advertisements appear:

"Manufacturers of spice mixtures and mustard. Goods made to order for wholesale."

"Grocers' spice mixtures and cayenne pepper a specialty."

Another reads:

"Manufacturers of all kinds of spice mixtures. My celebrated brand of P. D. pepper is superior to any made; samples sent on application. Goods shipped to all parts of the United States. Spice mixtures a specialty."

Out of all samples obtained at random from the miller or retail dealer, one-half to two-thirds have been found to be adulterated. Such a state of affairs is simply barbarous.

Cloves were prepared with the volatile oil extracted, and with the cloves there were ground clove-stems, roasted shells, wheat flour, peas, and minerals.

Allspice is ground with burnt shells and crackers, spent clove stems and charcoal and mineral color.

Ginger, with corn flour, mustard hulls, coloring, and yellow corn meal.

Mace, with flour buckwheat, wild mace, and corn meal.

Cayenne, with rice flour, stale shipstuff, yellow corn meal, tumeric, and mineral red.

Cassia, with ground shells and crackers, tumeric, and minerals.

Cinnamon, with cassia, peas, starch, mustard hulls and tumeric, mineral cracker dust, burnt shells, or charcoal.

Pepper, with refuse of all kinds, ground crackers, cocoanut shells, cayenne, peas, beans, yellow corn meal,

* Since the words on adulterations were written, the pure food laws of the different states have been greatly enforced, which has reduced adulterating almost to an entirety; but enough yet remains to make them of value.

buckwheat hulls, nutmegs, eereal, starch, mustard hulls, rice flour, chareoal, and pepper dust.

Mustard, with tumerie for color, and eayenne to tone it up, ecreal starch, peas, yellow corn meal, ginger, and gypsum.

By comparing prices in the following table of ground and whole spices, we may see to what extent adulteration is carried on. This adulteration is so largely practiced that it has given rise to a branch of the manufacturing industry of great magnitude, which has for its sole object the manufaeture of articles known as "spiee mixtures," or "pepper dust," whieh are known to the trade by such technical abbreviations as "P. D." This is a venerable fraud, which has expanded with rapidity.

TABLE

KINDS OF SPICE PRODUCT	GROUND	WHOLE PRICE
Cassia, Batavia, ...	7 to 7½ cents	10 cents
Cassia, China, ...	5¼ cents	42 cents
Cassia, Saigon, ...	36 to 40 cents	
Cloves, Amboyna, ...	27 cents	32 cents
Ginger, African, ...	5 cents	8 cents
Ginger, Cochin, ...	13 cents	12 cents
Mace, ...	50 cents	
Nutmegs, 110s, ...	48 cents	
Pepper, black, Singapore, . .	18 cents	18 cents
Pepper, black, West Coast, . .	16 cents	15 cents
Pepper, white, Penang, . . .	29 cents	32 cents
Pepper, red, Zanzibar, . . .	9 cents	10 cents
Pimento, ...	5 cents	
Mustard, yellow, ...	4 cents	12 cents
Mustard, brown, ...	5 cents	12 cents

Of course, the above prices are standard for the year when the comparison was made, but it is well to examine the figures as given and compare the priee of the whole spice with the ground. Such eomparison affords good indications of the extent of adulteration, since the meal is sold below the cost of the whole spiee. We now find this article put up in barrels, as "P. D. Pepper," "P. D. Ginger," "P. D. Cloves," and so on through the entire aromatic list. Different cities use different material for their pepper dust, using that which is most easily and, therefore, most cheaply obtained in their locality.

Fig. 20

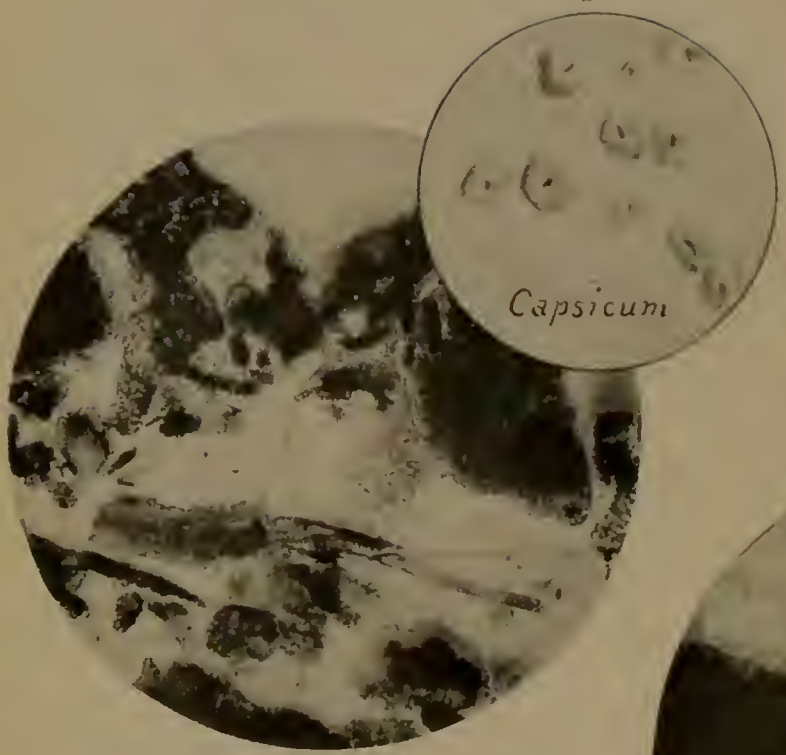


Fig. 44. PURE CAYENNE PEPPER

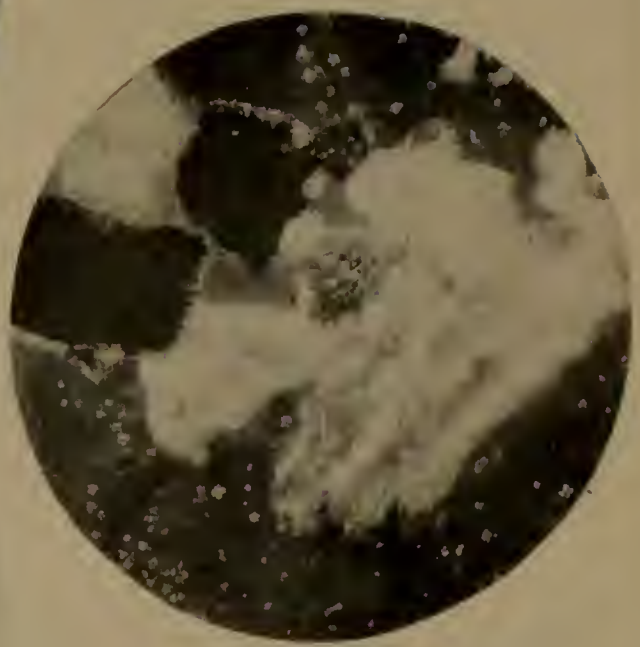
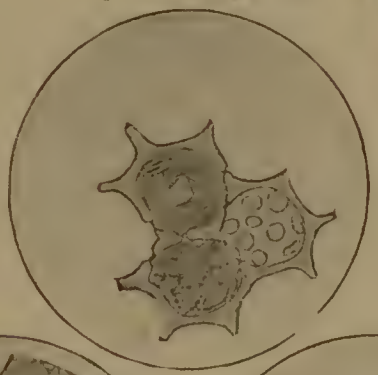


Fig. 45. CAYENNE PEPPER, ADULTERATED

Fig. 39. PALM SEED



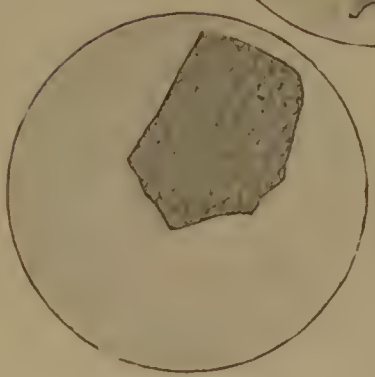


Fig. 38. LINSEED

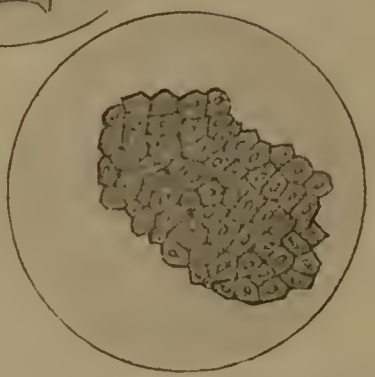


Fig. 40. EXTERIOR HUSK OF RAPE SEED

CHAPTER III.

HOW TO DETECT ADULTERATIONS IN SPICES — THEIR FORMATION AND ANALYSIS

AS far as its practical use to the merchant or consumer of spices is concerned, it would be as well, perhaps, if this chapter remained unwritten, and yet this treatise would be far from complete without it, as much of that which is herein contained is of the utmost importance, could it be put into practice.

In this chapter I attempt to give ways to detect adulterations, but the lamentable fact is that the general merchants have neither the time nor the facilities at hand to discover the foreign substance.

There are two principal ways of detecting adulterations in spices, which depend upon the difference in the structure of the cells between the adulterants and the true spice to which they are added, and also on their proximate composition. The former difference is recognized by the mechanical separation and by the use of the microscope, and the latter by chemical analysis.

The adulterations found in spices may be classed in four grades:

First. Integuments of grains of seeds, such as bran of wheat and buckwheat, hulls of mustard seed, flax seed, etc.

Second. Farinaceous substances of low price, as spice damaged in transportation or by long storage, middlings, corn meal, and stale ship bread.

Third. Leguminous seeds, as peas and beans, which contribute largely to the profit of the mixer.

Fourth. Various articles chosen with reference to their suitableness to bring up the mixtures, as nearly as possible, to the required standard color of the genuine article; various shades from light colors to dark brown may be obtained by skillful roasting of the farinaceous and leguminous substances, and a little tumeric goes a

long way to give a rich yellow color to real mustard made from pale counterfeit of wheat flour and terra-alba, or the defective paleness of artificial black pepper is brought to the desired tone by judicious sifting in of a finely pulverized charcoal.

From what has been said of the different foreign substances used for adulterations of spices and condiments, the necessity of knowing the structure and formation of the molecules of both principal and foreign elements which constitute the principal tissues of the particular plant-parts used for the adulterations is apparent, while in the chemical examination the principle of proximate analysis must be understood and applied.

It is also necessary that the analyst should be thoroughly acquainted with the application of the microscope, to determine the cellular structure, to make determinations of proximate principles in the substances under examination, since a mechanical separation by the microscope is more expeditious and is more at the command of the majority of persons searching for adulterations. For a mechanical analysis of food separations, a powerful microscope of good workmanship is required. It is better if it is supplied with a substance condenser and Nical prisms for the use of polarized light. Objectives of an inch and half inch, and, for some starches, one-fifth inch, equivalent focus, are sufficient. One eye-piece of medium depth, one-fourth to one-sixth, adjusted at 160 degrees is enough, with plenty of good light. The analyst should also have plenty of sieves of 40 to 60 meshes to the inch to be used for separation, which will furnish means of detecting adulterants and selecting particles for investigation, and will often reveal the presence of foreign material without further examination, since many adulterants are not ground so fine as the spices to which they are added, and by passing the mixtures through the sieves the coarser particles remaining will be either recognized at once by an unaided educated eye or with a pocket lens.

In this way, tumeric is readily separated from mustard and yellow corn meal; mustard hulls and cayenne, from low-grade pepper. Where a pocket lens is insuffi-

cient, the higher power of the microscope is confirmatory. It is also desirable to be provided with a dissecting microscope for selecting particles for examination from large masses of ground spice, and for this a large Zeiss stand, made for that purpose, is best, but simpler forms, or even a hand lens, will answer the purpose.

For smaller apparatus, a few beakers, watch crystals, stirring rods, and specimen tubes, with bottles for reagents, will be sufficient, in addition to the ordinary glass slides and covers for glasses. The reagents required for chemical analysis (if no great amount is used) are as follows:

Strong alcohol,

Ammonia,

Chloralhydrate solution — 8 parts to 5 of water,

Glycerine,

Iodine solution — water 15 parts, iodide of potash 20 parts, iodine 5 parts; water distilled.

Balsam in benzol and glycerine jelly are desirable for mounting media, and some wax sheets will be needed for making cells. In addition, the analyst should supply himself with specimens of whole spices, starches, and known adulterants, which may be used to become acquainted with the forms and appearances to be expected; it is easier to begin one's study in this way on sections prepared with the knife, and afterwards the powdered substance may be taken up.

To study the physiological structure in the spices and their adulterants is quite difficult, as the vegetable tissues which make up the structure of the spices and the materials of a vegetable origin which are added as adulterations consist of cells of different forms and thickness; those which are most prominent and common are the parenchyma, the sclerenchyma fibrous tissue, and the fibro-vascular bundles. Spiral and dotted vessels are also common in several of the adulterants, and in the epidermis are other forms of tissue which it is necessary to be well acquainted with, though not physiologically.

The parenchyma is the most abundant tissue in all material of vegetable origin, making up the largest pro-

portion of the main part of the plant. It is composed of thin wall cells which may be recognized in the potato and in the interior of the stems of maize. In the latter plant, also, the fibro-vascular system is well exemplified, running as scattered bundles between the nodes or joints.

Fibrous tissue consists of elongated thick-walled cells of fibers which are very common in the vegetable kingdom and are well illustrated in flax, but they are not so commonly used for adulterating purposes. They are optically active, and in the shorter forms they somewhat resemble the cells next described. They are seen in one of the coats of buckwheat hulls and in the outer husks of the cocoanut.

The sclerenchyma is found in the shells of many nuts and in one or two of the spices, the cells being known as stone cells, from the great thickening of their walls. To them is due the hardness of the shell of the cocoanut, the pits of the olive, etc. (See Fig. 1.)

Spiral and dotted vessels are common in woody tissue and are readily recognized. All these forms an analyst should make himself familiar with.

In pepper and mustard the parenchyma cells are prominent in the interior of the berry, while those constituting the outer coats are indistinct in the pepper, because of their deep color; but in the mustard are characteristics of this particular species. In fact, in many of the spices, and especially those which are seeds, the forms of the epidermal cells are very striking, and, if no attempt is made to classify them their peculiarities must be carefully noted, as the recognition of the presence of foreign husky matter depends upon a knowledge of the normal appearance in any spice.

The fibro-vascular bundles are most prominent in ginger and in the barks, while in the powdered spices they are found as stringy particles.

The sclerenchyma, or stone cells, as shown in Fig. 1, are common in the adulterant, especially in cocoanut shells, where may also be seen numerous spiral cells, and in the exterior coats of fibrous tissue.

As to aids to distinguish these structures, the following peculiarities may be cited:

Fig. 3

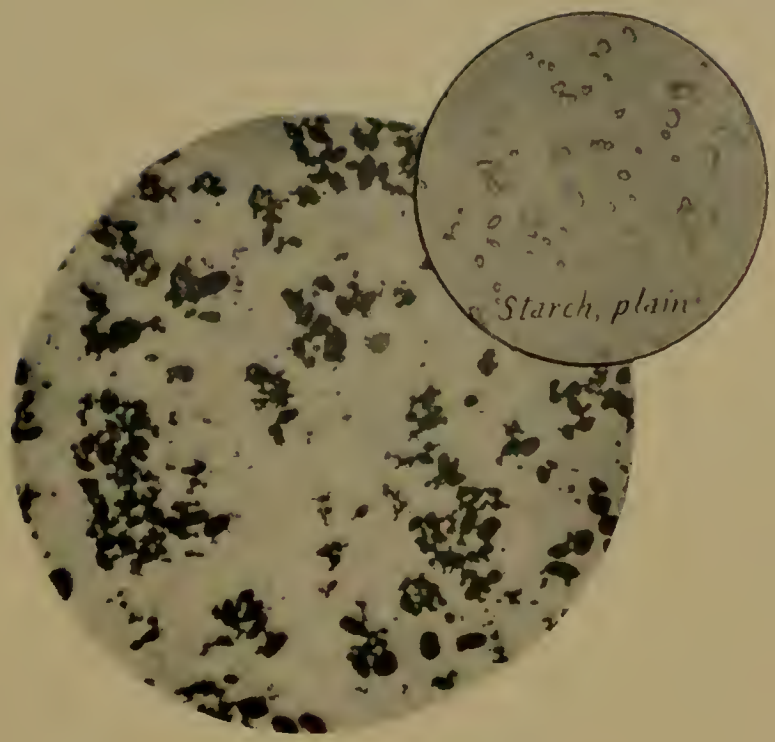


Fig. 2. STARCH STAINED WITH IODINE

Fig. 5

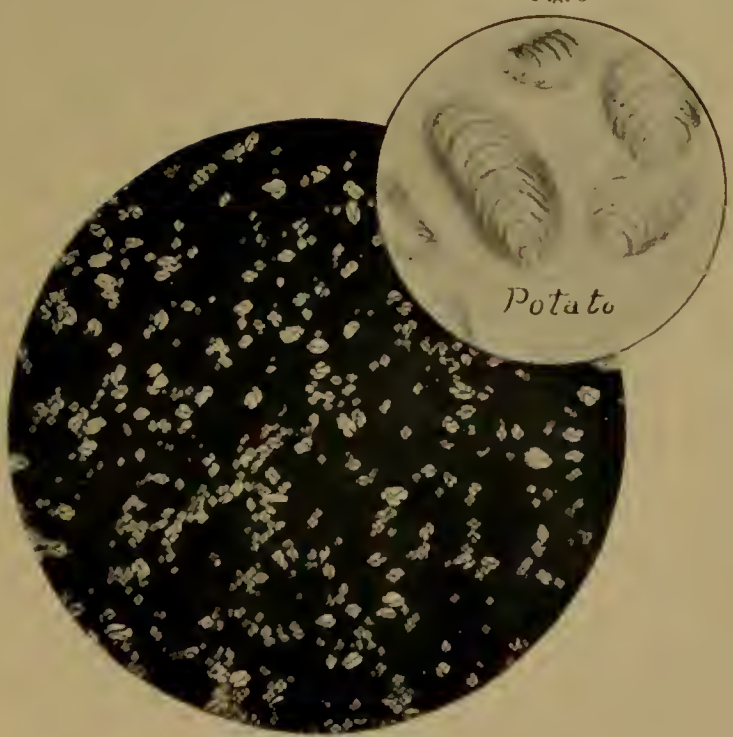


Fig. 4. POTATO STARCH

Fig. 1. STONE CELLS

The stone cells and fibrous tissue are optically active, and are, therefore, readily detected with polarized light, shining out in the dark field of the microscope as silver-white or yellowish bodies.

The fibro-vascular bundles are stained deep orange brown with iodine, owing to the nitrogenous matter which they contain, while parenchyma is not affected by this reagent, aside from the cell contents, nor has it any action on polarized light, remaining quite invisible in the field with crossed prisms.

Next to cellular tissue, starch is the most important element for consideration in the plant, which possesses an organized structure and is distinguished by its reaction with iodine solution, which gives it a deep blue or blackish-blue color, varying somewhat with different kinds of starch and with the strength of the reagent, and its absence is marked by no blue color under the same circumstances.

Heat, however, as in the process of baking, so alters starches, converting them into dextrine and related bodies, that they give a brown color with iodine, instead of a blue-black; they are no longer starch, however; their form, not being essentially changed, permits of their identification, with a study of the size and shape of the granules of the hilum, or central depressions of nucleus, and the prominence and position of the rings.

By polarized light and selenite, the starches of tubers showed a more varied play of colors than the cereal and leguminous starches which are produced above ground.

The starches we are to consider are those of a limited number to be met with in spices and their adulterants, and one must be able readily to recognize the following:

STARCH NATURAL TO SPICES AND CONDIMENTS	STARCHES OF ADMIXTURES	
	Wheat and other Cereals:	
Ginger,	Corn,	Barley,
Pepper,	Oats,	Potato.
Nutmegs,	Maranta and other arrowroots:	
Cassia,	Rice,	Sago,
Pimento,	Beans,	Buckwheat.
Cinnamon,	Peas,	
Cayenne.		

No one of these is complete in itself, but from the characters given, and with the aid of illustrations, the starches which commonly occur in substances which are here considered may usually be identified without difficulty.

For the benefit of those who have had no experience with the microscope, I will give the following directions:

Take a small portion of the starch or spice to be examined upon a clean camel's hair brush and dust it upon a common slide, blow the excess away and moisten that retained with a drop of a mixture of equal parts of glycerine and water, or with glycerine and camphor water, and cover with a glass. It is well to have a small supply of the common starches in a series of tubes which can be mounted at any moment and used for comparison. They may be permanently mounted by making with cork borers, of two sizes, a wax cell ring equal to the diameter of the cover glass and, after cementing the cell to the slide with copal varnish thinned with turpentine and introducing the starch and glycerine mixture, fixing the cover glass on after running some of the cement over the top of the ring. A little experience will enable one to put the right amount of liquid in the cell and to make a preparation that will keep for some time. After several months, however, it is hard to distinguish the rings which mark the development of the granule, and it is better to keep it fresh.

For other purposes, the starches should be mounted in prepared Canada Balsam, or by well-known methods in which they may be preserved indefinitely, but they are scarcely visible with ordinary illumination and must be viewed by polarized light, which will bring out distinctive characters not seen as well, or not at all, in the other mounts. When mounted in the manner described, in glycerine and water, or in water alone, if for temporary use, under a microscope with one objective of equivalent focus of one-half to one-fifth inch, and with means for oblique illumination, the starches will display characteristics which are illustrated in Figs. 2, 3, and 4. The illustrations have been drawn from Nature; Fig. 2 gives starch stained with iodine; Fig. 3 gives shape and size

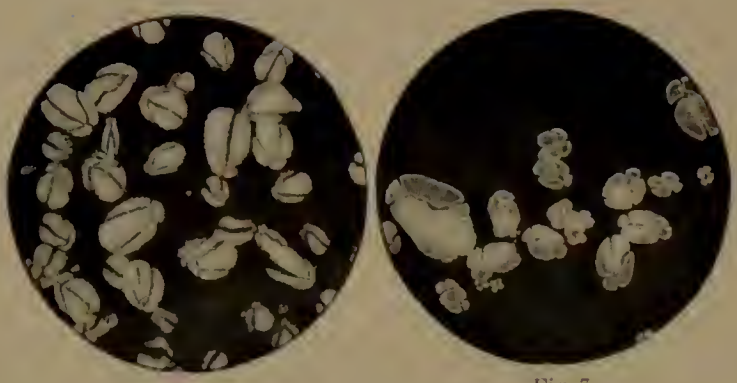


Fig. 6 Fig. 7

POTATO STARCH

Fig. 9 Fig. 10

Fig. 8. MARUNTA STARCH

of plain starch, and presence or absence of a nucleus, or hilum, and of the rings and their arrangements which can be made out. The starch is classed in its proper place.

If mounted in balsam, their appearance is scarcely visible under any form of illumination with ordinary light, the index refraction of the granules and the balsam being so similar, but when polarized light is used the effect is a striking one. (See plates of ginger, where it is easy to distinguish all the characteristics, except the rings, the center of the cross being at the nucleus of the granule.)

The principal starches which are met with may be described as follows in connection with illustrations given, beginning with those of the arrowroot class, including potato, ginger, and tumeric.

POTATO STARCH

Potato starch grains are very variable in size, being found from .05 to .10 millimeter in length, and in shape from oval and allied forms to irregular, and even round in the smallest; these variations are illustrated in Fig. 4, but the frequency of the smaller granules is not as evident as in Figs. 5 and 6. The layers in some granules are very plain and in others are hardly visible. They are rather more prominent in the starch obtained from a freshly cut surface. The rings are more distinct near the hilum, or nucleus, which in this, as in all tuberous starches, is eccentric, shading off toward the broader or more expanded portion of the granules.

The hilum appears as a shadowy depression (Fig. 4) and, with polarized light, its position is well marked by the junction of the arms of the cross. It will be found by comparison of Fig. 6 and Fig. 7, that in the potato it is more often at the smaller end of the granules, and that in the arrowroot it is at the larger. With polarized light and a selenite plate a beautiful play of colors is obtained.

The smaller granules, by their nearly round shape, may be confused with other starches, but their presence at once serves to distinguish them from Maranta or Bermuda arrowroot starch.

Rarely, compound granules are found composed of two or three single ones each within its own nucleus.

Of the same type as the potato starch are various arrowroots. The only ones commonly met with in this country are the Bermuda, the starch of the rhizome of Maranta arundinacea, and the starch of tumeric.

MARANTA STARCH

The granules are not usually so varied in size or shape as those of the potato, as may be seen in Figs. 8, 9, and 10. They average about .07 millimeters in length. They are about the same size as the average of those of the potato, but are never found as large or as small. This fact, together with the fact that the end at which the nucleus appears is broader in the Maranta and more pointed in the potato, enables one to distinguish the starches without difficulty. With polarized light, the results are similar to those seen with potato starch, and, by this means, the two varieties may be readily distinguished by displaying, in a striking way, the forms of the granule and the position of the hilum, as is illustrated in Figs. 8 and 9.

CIRCUMA

Circuma, or tumeric starch (Fig. 11), though of the arrowroot class, is quite distinct in appearance from these we have described, being most irregular in outline, so that it is impossible to define its shape or to do more than to refer to the illustration. Many of the granules are long and narrow and drawn out to quite a point. The rings are distinct in the larger, and the size is about that of Maranta.

Ginger starch (Figs. 12, 13, and 14) is of the same class as potato and Maranta and several others which are of underground origin. In outline, it is not oval like those named, but is more rectangular, having more obtuse angles in the larger granules and being cylindrical or circular in outline in the smaller; its average size is nearly the same as Maranta starch, but it is much more variable in size and form, the rings being scarcely visible

Fig. 18

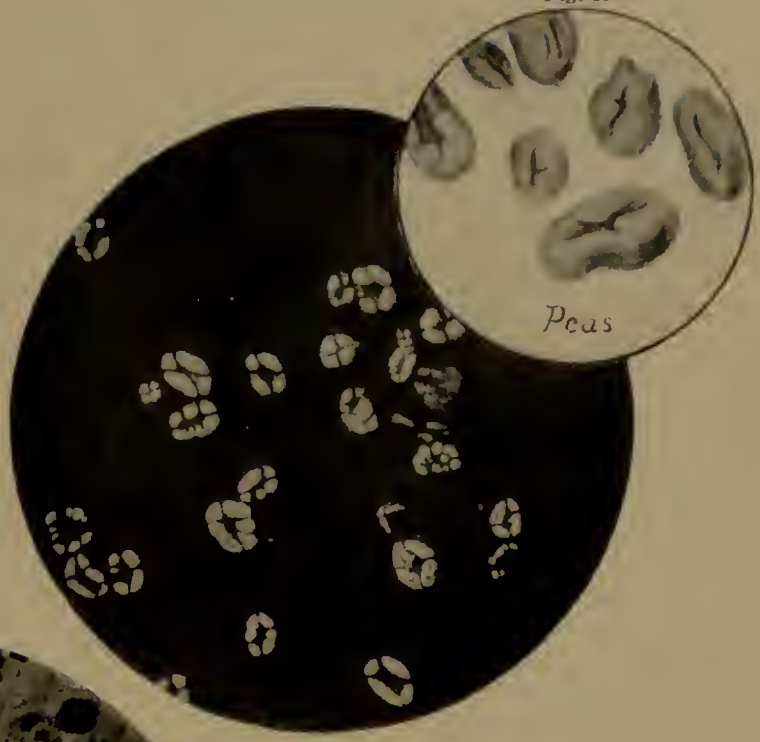


Fig. 17. PEAS

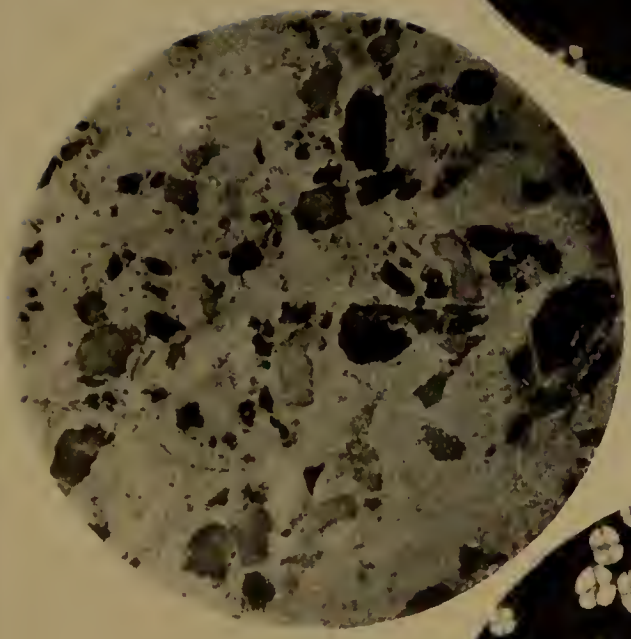


Fig. 46. CINNAMON ADULTERATED

Fig. 16

Fig. 15. BEANS

Fig. 43. PEPPER ADULTERATED

Fig. 21

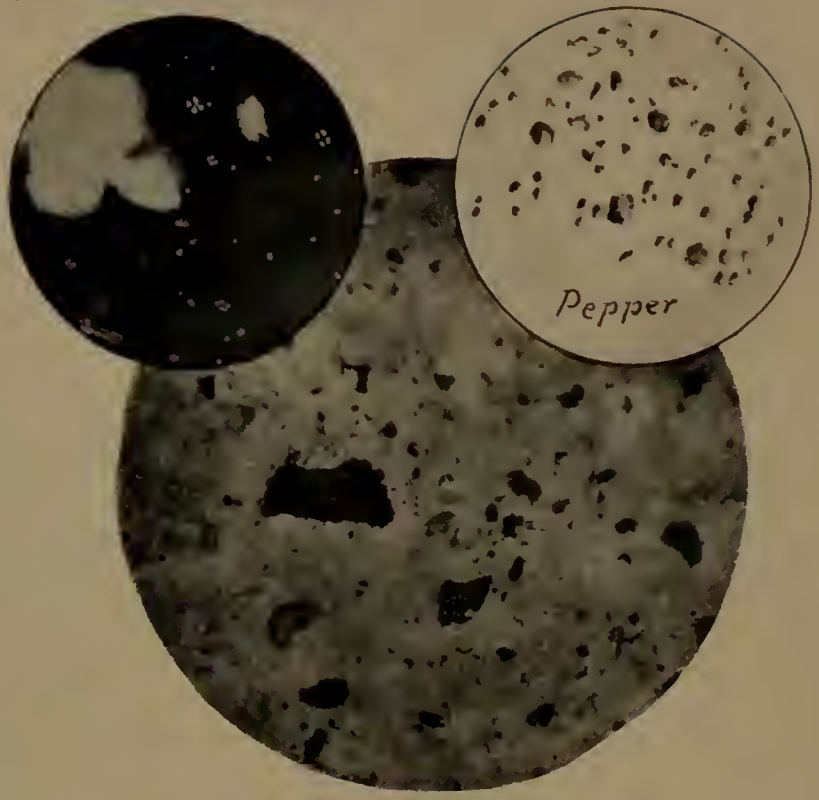


Fig. 42. P. D. PEPPER

Fig. 28

Fig. 29

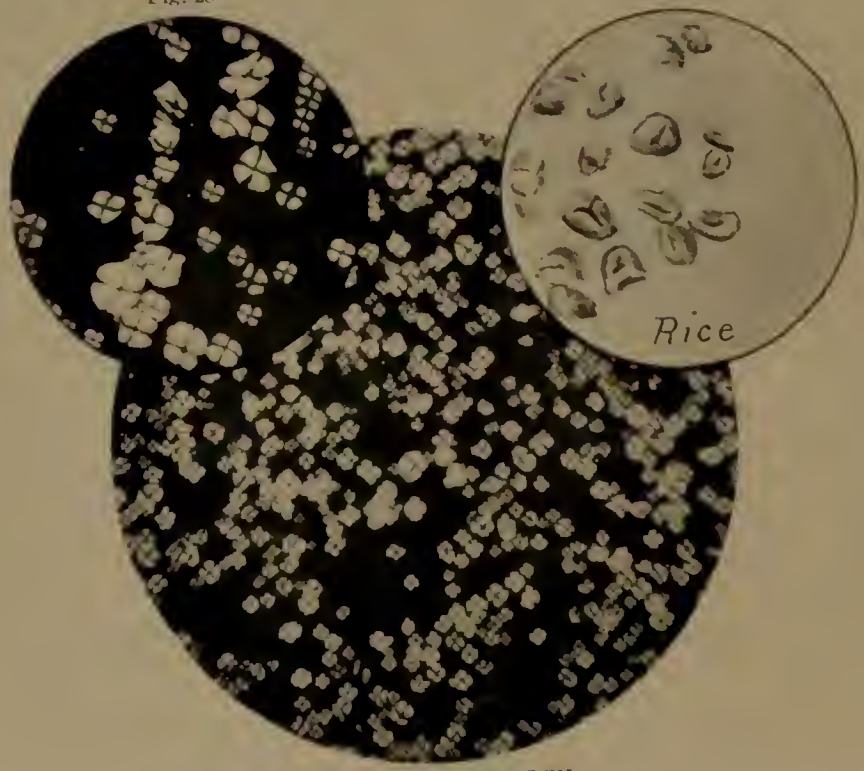


Fig. 27. RICE STARCH

even with most favorable illuminations. Fig. 12 shows ginger adulterated.

LEGUMINOUS STARCHES

Such as those of beans and peas (Figs. 15, 16, 17, and 18), produce but a slight effect under polarized light; the rings are scarcely visible, and the hilum is stellate or much cracked along a median line. This characteristic is more marked in the bean than in the pea. In the latter it resembles fresh dough kneaded again into the center as in making rolls, and in the former the shape assumed by the same after baking. In both it varies in size from .025 to .10 millimeter in length.

NUTMEG STARCH

Fig. 19 has rings scarcely visible and not iridescent with polarized light. It is smaller in size than the preceding, which it resembles, being at times as long as .05 millimeter down to smaller than .005 millimeter, and of extremely irregular form, having angular depressions and angular outlines. It is distinguished by a budded appearance caused by the adherence of small granules to the larger.

CAPSICUM STARCH

Fig. 20 is nearly circular or rounded polyhedral in forms with scarcely visible rings, and in most cases a depressed hilum, resembling in size and shape corn starch, but having peculiar irregularities which distinguish it, such as rosette-like formation on a flattened granule, or a round depression at one end. It does not polarize as actively as maize starch and can be distinguished from rice by the greater angularity of the latter.

PEPPER STARCH

Fig. 21 is the most minute starch which is usually met with, not averaging over .001 millimeter nor exceeding .005. It is irregularly polyhedral and polarizes very well, but requires a high power to discover any detail when a hilum is found. It cannot be confused with other starches.

CINNAMON STARCH

Figs. 22 and 23 have an extremely irregular polyhedral or distorted granules, often united in groups with smaller granules and adherent to the larger ones. In size, it varies from .001 to .025 millimeter, averaging nearly the latter size. In some granules the hilum ean be distinguished, but no rings; it is readily deteeted with polarized light.

BUCKWHEAT STARCH

Fig. 24 is very eharaeteristic. It consists of a ehain or groups of angular granules with a not very evident eireular nucleus and without rings. The outline is strikingly angular and the size not very variable, being about .01 to .015 millimeter.

MAIZE OR CORN STARCH

Figs. 25 and 26 have granules largely of the same size from .02 to .03 millimeter in diameter, with now and then a few whieh are mueh smaller; they are mostly eireular in shape or, rather, polyhedral with rounded angles. They form very brilliant objeets with polarized light, but with ordinary illumination show but the faintest signs of rings and a well-developed hilum, at times star-shaped and at others more like a eircular depression.

RICE STARCH

Figs. 27, 28, and 29, is very similar to eorn stareh, and is easily confused with it, being about the same size. It is, however, distinguished from it by its polygonal form and its well-defined angles. The hilum is more prominent and more often stellate, or linear, and several grains are at times united.

WHEAT STARCH

Figs. 30 and 31 are quite variable in size, varying from .05 to .012 millimeter in diameter, and this stareh belongs to the same class as barley and rye; the hilum is invisible and the rings are not prominent; the granules are eircular disks in form, and there are now and then contorted depressions, resembling those in the pea

Fig. 41. PURE CASSIA

Fig. 23

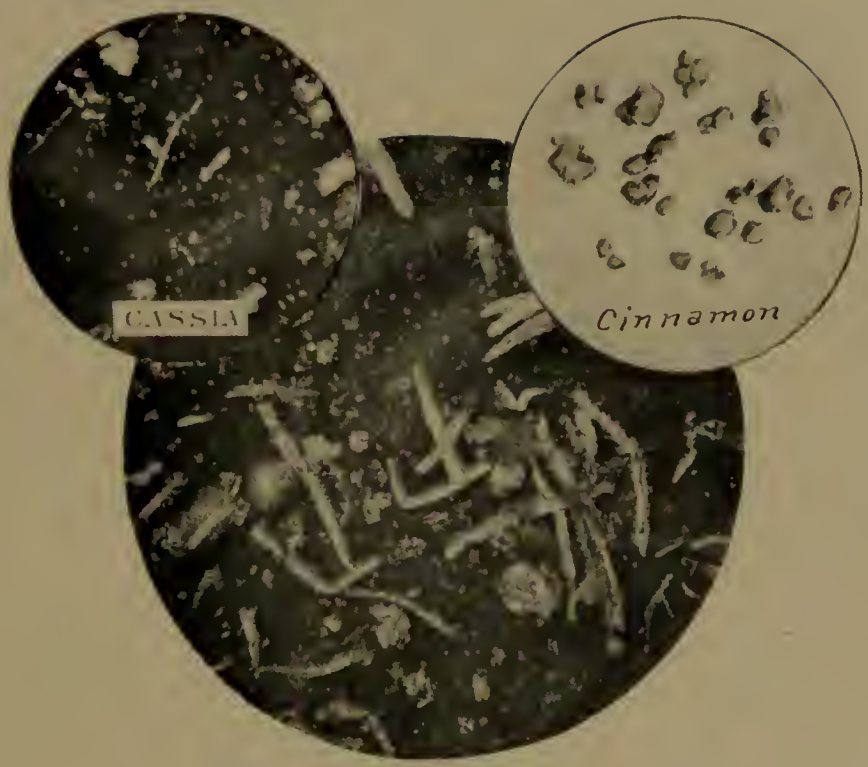


Fig. 22. PURE CINNAMON

Fig. 26

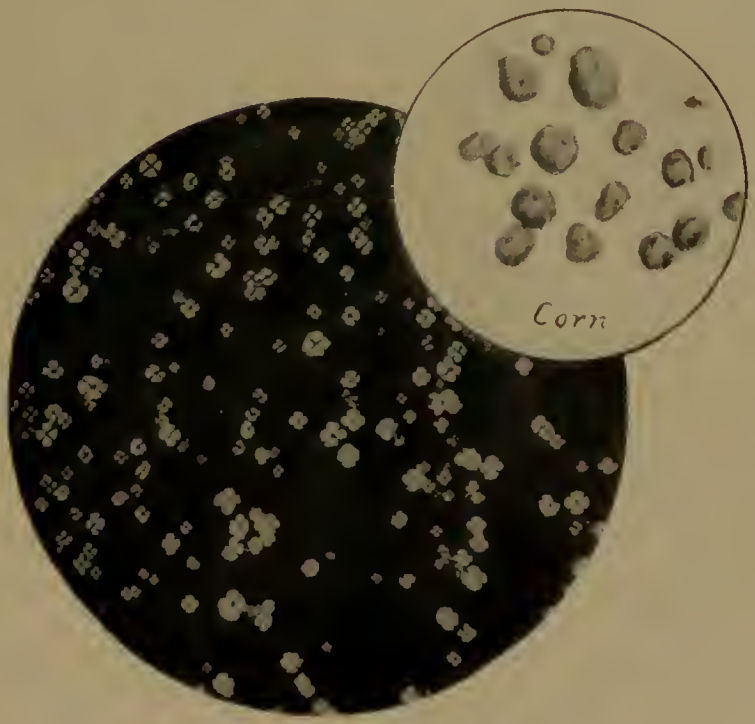


Fig. 23. MAIZE STARCH

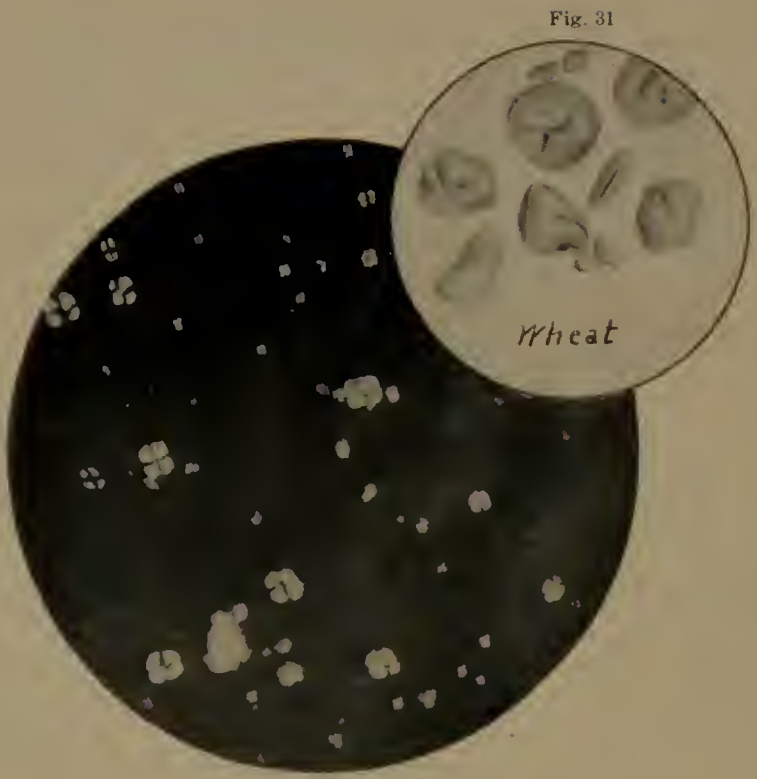


Fig. 30. WHEAT STARCH

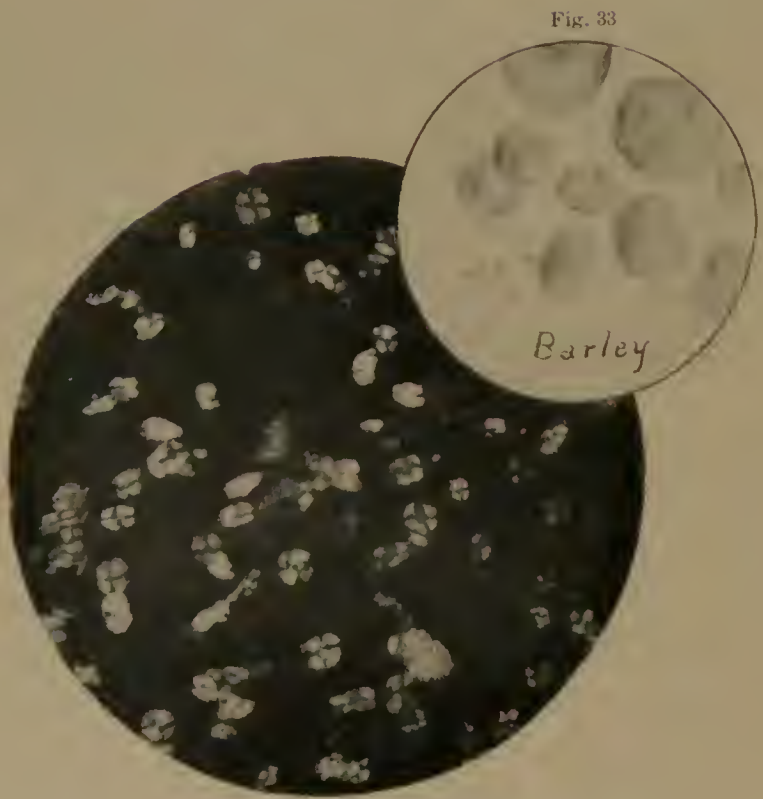


Fig. 32. BARLEY STARCH

starch; it is the least regular of the three starches and does not polarize actively.

BARLEY STARCH

Figs. 32 and 33 are quite similar to that of wheat, but barley starch does not vary so much in size, averaging .05 millimeter. It has rings more distinct and very small granules adhering to the largest in bud-like forms.

RYE STARCH

Fig. 34 is more variable in size, many of the granules not exceeding .02 millimeter while the largest reach .06 to .07 millimeter. It lacks distinctive characteristics entirely, and is the most simple in form of all starches described.

OAT STARCH

Figs. 35 and 36, is unique, being composed of large compound masses of polyhedral granules from .12 to .02 millimeter in length, the single granules averaging .02 to .015 millimeter. It does not polarize actively, as may be seen in the figures, and displays neither rings nor hilum.

The first sign of maize or corn meal as an adulterant is the thin outer coat which becomes detached in milling and is not readily crushed. In yellow corn it has a pinkish color, and simple, longitudinal cells.

Broken rice is sometimes used as a dilutant; it may be recognized by the brilliant appearance of the hard white particles which may be picked out of the spice under a hand lens.

The two cereals named (broken rice and maize corn) are the only ones which are commonly met with that introduce starch.

Wheat bran (Fig. 37) is occasionally added, which can be recognized by its distinctive structural character and is better understood from an authentic specimen, which should be soaked in chloral-hydrate.

As modified cereals, we find refuse bread, cracker dust, and stale ship bread, in which the wheat starch is much changed from its original form by the heat and moisture, so that at times it might be confused with leguminous

starch, but the softness of the particles and the ease with which they fall to pieces in water reveal their true name.

Oil seed, oil cake, and husk (Figs. 38, 39, and 40) are very commonly used and are readily recognized by the peculiar structure of the outer coats of the seed. The particles, which can be usually found and selected with a dissecting microscope, should be examined in alcohol or glycerine, or a mixture of the two, as the outer coats of some seeds, such as mustard, are swollen by water and become indistinct. Many varieties of the cruciferous seeds resemble it very much, so that it is difficult to distinguish them, but it is generally recognized by the outer layer of hexagonal cells and a middle and inner coating, which consists of peculiar angular cells, the latter being much larger than the former, which are the most characteristic feature, and should be compared with seeds of known origin. After soaking in chloral-hydrate, the remaining interior layers are, perhaps, more easily made out, in some cases, after moderate bleaching with nitric acid and chlorate; the interior of this seed is not blued by iodine.

Peanut, or ground nut cake, is recognized by the characteristic structure of the red-brownish coat, which surrounds the seed, and consists of polygonal cells with peculiar saw-toothed thickening of the walls. The seed itself consists of polygonal cells full of oil and starch granules, which are globular in form and not easily confused with pepper starch. The structure of the brown membrane is best made out in chloral-hydrate, which removes the red color and leaves the fragments of a bright yellow.

Linseed cake is distinguished by the fact that its husk is made up of one or two characteristic elements. The outer coat, or epidermis, is colorless and swells up in water, forming a mucilage, like the mustard seed. Beneath this is a layer of thin, round, yellow cells, while the third is very characteristic and consists of narrow and very thick-walled dotted vessels; next to these is an inner layer of compact polygonal cells, with fairly thin, but still thickly dotted, white walls and dark-brown contents containing tumeric. The endogen and embryo are

Fig. 36.

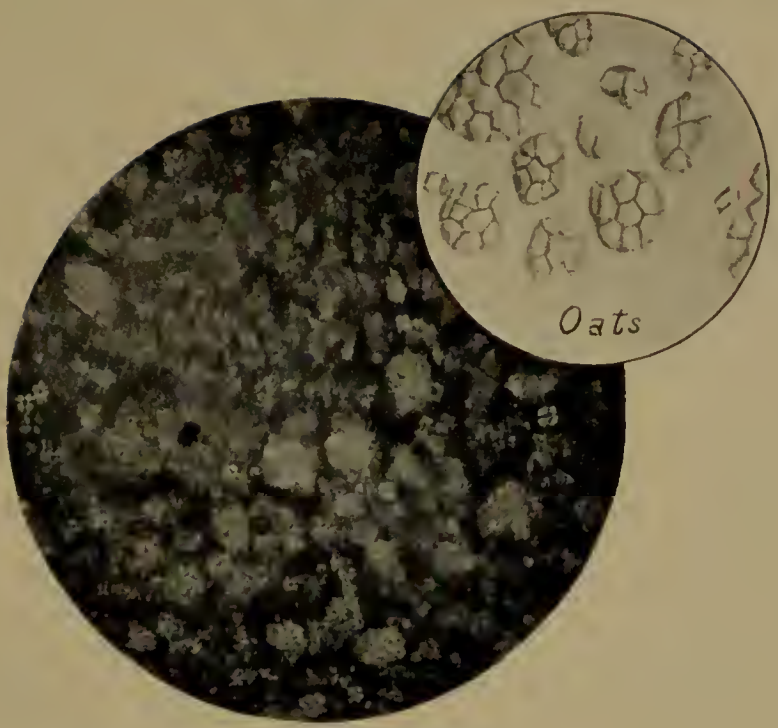


Fig. 35. OAT STARCH

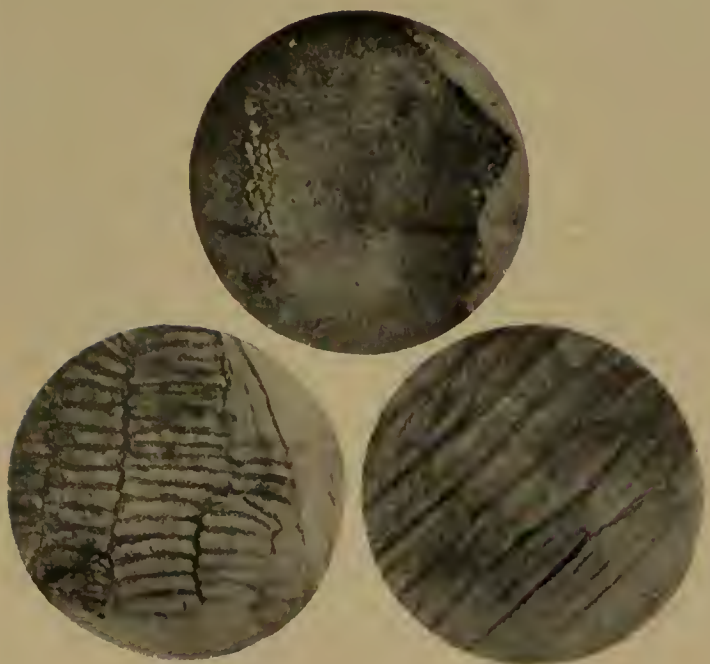
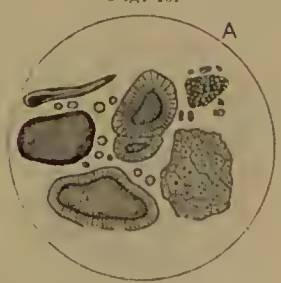


Fig. 37. WHEAT BRAN

Fig. 46.



POWDERED ALLSPICE SHOWING PORT WINE CELLS. (A) STARCH

free from starch and will not color yellow by potash, as is the case with mustard and rape seed cake.

Cocoanut shells are often used, and have numerous, both long and short, stone cells and spiral vessels from this fibrous tissue; the long stone cells having thinner walls than the shorter cells, all of which are readily seen after bleaching. When the shells are roasted, they refuse to bleach, and it is then only possible to class the particles, on which the reagents do not act, as roasted shells or charcoal, which are frequently used in pepper to give desired color to material rendered too light by white adulterants.

Buckwheat, after bleaching, shows a preponderance of tissue made up of long, slender, and pointed sclerenchyma cells and a smaller amount of reticulated tissue, resembling the cereals somewhat and cayenne pepper. Portions of the interior of the seed are also visible and consist of an agglomeration of small hexagonal cells which originally contained starch. The starch is readily recognized by its peculiar characteristics. The sclerenchyma is, of course, optically active and forms a beautiful and distinctive object with polarized light. Sawdust of various woods may be recognized by the fragments of various spiral and dotted vessels and fibrous material which are not found in spices or in other adulterants.

Rice bran is made up prominently of two series of cells at right angles to each other, which make up the outer coats of grain, the structure being best made out after soaking in chloral-hydrate; the cells of one series are long, small, and thin-walled, and are arranged in parallel bundles; the others have very much thicker walls and are only two or three times as long as they are broad.

Clove stems are distinguished by their peculiar yellow dotted vessels and their large and quite numerous cells, neither of which is seen prominently in the substances which are adulterated. The peculiarities of adulterants should be carefully confirmed and the eye trained by practice so as to become accustomed to recognizing their structure by a study of the actual substance.

Take one gram of powdered spice which will pass a 60-mesh sieve and dry at 150 degrees to 110 degrees C. in an air bath provided with a regulator, until a successive weighing shows a gain, which denotes that oxidization has begun, which takes about 12 hours, or over night; the loss is water, together with the largest part of volatile oil. Deduction of the volatile oil, as determined in the ether extract, will give a close approximation of water. The ash portion is determined by incineration at a very low temperature, such as may be attained in a gas muffle, which is the most convenient arrangement for work of this kind. The proportion of ash insoluble in acid may be determined where there is a reason to believe that sand is present.

To find the amount of volatile oil by ether extract: Two grains of substance are extracted for twenty-four hours in a siphoning extraction apparatus, being first placed in a test tube, which is inserted into a continuous extraction apparatus of the intermittent siphon class, the tube used being an ordinary test tube, the bottom of which has been blown out. A wad of washed cotton of sufficient thickness is put in the lower end of the tubes to prevent any solid particles of the sample from finding their way into the receiving flask; another wad of cotton is packed on top of the sample, and the apparatus is then so adjusted that the condensed ether drops into the tube and percolates through the sample siphons into the receiving flask. In this way the operation is continued the length of time named. The best ether should be used to avoid extracting substances other than oil soluble in alcohol, and to continue the extraction for at least the time named, as piperine and several other proximate principles are not extremely soluble in ether. On stopping the extraction, the extract is washed into a light, weighed, glass dish, and the ether is allowed to evaporate spontaneously, but not too rapidly, for the reason that water, which is difficult to remove, might be condensed into the dish. In a short time the ether will disappear, and the dish is placed

Fig. 13. PURE GINGER

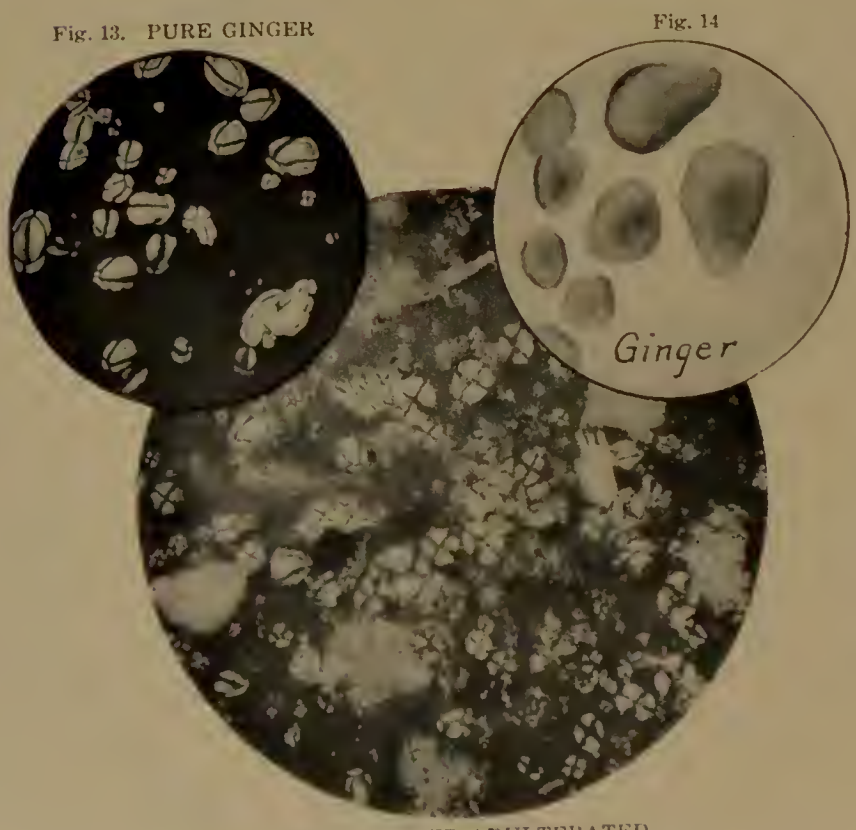


Fig. 12. GINGER ADULTERATED

in a dessicator with pumice and sulphuric acid, not with chloride of calcium, which has been shown to be useless. It is allowed to remain over night to remove any moisture; the loss of oil by this proeess is scarcely appreciable. The dish is next weighed and afterward heated to 110 degrees C. for some hours, to drive off the volatile oil, beginning at a low temperature, as the oil is easily oxidized, and then is not volatile oil. The residue is weighed, the differenee being calculated to volatile oil and examined as to its composition of purity.

Alcohol extract is made in the same manner as the ether extract, using, of course, the substance extraeted. The solvent may be either absolute aleohol — that of 95 per eent. by volume, or 80 per cent. by weight, the latter being preferable in most cases, as there is no definite point with the stronger spirit at whieh the extraction is completed.

The amount of redueing material produeed by boiling the spiees with dilute aeids serves with several as an index of purity. In the case of pepper, whieh eontains a large amount of stareh, the addition of fibrous adulterants reduces the equivalent of reducing sugar, whieh are indicated in the solution after boiling with aeid. Tumeric is always found in spices, such as cloves and pimento of good quality.

It has been said that preliminary extractions of the material with the best ether is neeessary to remove oil and other substanees, not tannin on whieh permanganate may aet; ordinary ether will not answer, as it contains so much aleohol and water as to dissolve some of the tannin. The substance freed from ether should be extraeted with boiling water and the extraet made up to such dilution that 10 CC. is equal to about 10 CC. of the thirtieth normal, — permanganate solution used. The titration must be performed slowly to insure aeeuracy, the permanganate being run in at the rate of not more than a drop in a second, or three drops in two seeonds. The eye must become aecustomed to the bleaehing of the indigo used, and select some one tint of yellow, as the end of reaction is then possible to duplicate. That part of the material analyzed, which is insoluble in aeid and

alkali of certain strength after treatment for a definite length of time, at a definite temperature, is called *crude fiber,* and it may be described as follows:

Select two grains of substance 200 CC. of 5 per cent. hydrochloric acid; steam bath two hours, raising the liquid to a temperature of 90 degrees to 95 degrees C. filtration on linen cloth, washing back into beaker with 200 CC. 5 per cent. sodic-hydrate; steam bath two hours, filtration on asbestos, washing with hot water, alcohol, and ether, drying at 120 degrees, weighing, ignition and crude fiber from loss in weight.

REAGENTS AND APPARATUS

(1.) Hydrochloric acid whose absolute strength has been determined.

(a.) By precipitating with silver nitrate and weighing the silver chloride.

(b.) By sodium carbonate, as described in Fresenius Quantitative Analysis, second American edition, page 680 (c), by determining the amount neutralized by the distillate from a weighed quantity of pure ammonium-chloride boiled with an excess of sodium-hydrate.

(2). Standard ammonia whose strength relative to the acid has been accurately determined.

(3). C. P. sulphuric acid specific gravity 1.83, free from nitrates, and also from ammonium sulphates, which are sometimes added in the process of manufacture to destroy oxides of nitrogen.

(4). Mercuric-oxide, Hgo, prepared in the wet way. That prepared from mercury nitrate cannot safely be used.

(5). Potassium permanganate tolerably finely pulverized.

(6). Granulated zinc.

(7). A solution of 40 grams of commercial potassium sulphide in one liter of water.

(8). A saturated solution of sodium-hydrate, free from nitrates which are sometimes added in the process of manufacture to destroy organic matter and improve the color of the product.

(9). Solution of cochineal, prepared according to Fresenius Quantitive Analysis, second American edition, page 679.

(10). Burettes should be calibrated in all cases by the user.

(11). Digestion flasks of hard, and moderately thick, well-annealed glass, which should be about 9 inches long, with a round, pear-shaped bottom, having a maximum diameter of 2½ inches and tapering out gradually in a long neck, which is three-fourths of an inch in diameter at the narrowest part and flared a little at the edge. The total capacity is 225 to 250 cubic centimeters.

(12). Distillation flasks of ordinary shape, 550 cubic centimeters capacity, and fitted with rubber stoppers, and a bulb tube above to prevent the possibility of sodium-hydrate being carried over mechanically during distillation; this is adjusted to the tube of the condenser by a rubber tube.

(13). A condenser with tube of block tin is best, as glass is decomposed by steam and ammonia vapor, and will give up alkali enough to impair accuracy; the tank should be made of copper, supported by wooden frame, so that its bottom is 11 inches above the workbench on which it stands. It should be about 16 inches high, 32 inches long, and 3 inches wide, gradually widening 6 inches toward the top; the water-supply tube should extend to the bottom, and there should be a larger overflow pipe above.

The block tin condensing tubes should be about ⅜ of an inch inner measure and seven in number, entering the tank through holes in the front side of it near the top above the level of the overflow, and pass down perpendicularly through the tank and out through the rubber stoppers, tightly fitted into holes in the bottom; they should project 1½ inches below the bottom of the tank, and connect by short rubber tubes, with glass bulb tubes, of the usual shape, which dip into glass precipitating beakers. These beakers should project about 6½ inches high by 3 inches in diameter below, gradually narrowing above, and should be about 500 cubic centimeters

capacity. The titration can be made directly in them. The seven distillation flasks should be supported on a sheet-iron shelf attached to the wooden frame which supports the tank at the front; where each flask is to stand, a circular hole should be cut with three projecting lips to support the wire gauze under the flask, and three other lips to hold the flask in place, and to prevent its moving laterally out of place while distillation is going on. Below the sheet-iron shelf should be a metal tube carrying seven Bunsen burners, each with a stopcock like those of a gas combustion furnace. These burners are of larger diameter at the top, which prevents smoking when covered with fine gauze to prevent the flame from striking back.

(14). The stand for holding the digestion flask should consist of a pan of sheet iron, 29 inches long by 8 inches wide, on the front of which is fastened a shelf of sheet iron as long as the pan, 5 inches wide and 4 inches high. In this are cut six holes 1⅝ inches in diameter. At the back of the pan is a stout wire running lengthwise of the stand, 8 inches high, with a bend or depression opposite each hole in the shelf. The digestion flask rests with its lower part over a hole in the shelf and its neck in one of the depressions in the wire frame, which holds it securely in position, and heat should be supplied with Bunsen burners below the shelf.

THE DETERMINATION

One gram of the substance to be analyzed is brought into a digestion flask with approximately 0.7 grams of mercuric-oxide, and 20 cubic centimeters of sulphuric acid, and the flask is placed on the frame described in an inclined position, and heated below the boiling point of the acid for from five to fifteen minutes, or until frothing has ceased. The heat is then raised until it boils briskly. No further attention is required until the contents of the flask have become a clear liquor, which is colorless, or, at least, has only a very pale straw color.

The flask is then removed from the flame, held upright, and, while yet hot, potassium permanganate is dropped in carefully and in small quantities at a time

until, after shaking, the liquid remains of a green or purple color.

After cooling, the contents of the flask are then transferred to the distilling flask with water, and to this 25 cubic centimeters of potassium-sulphide solution are added, 50 cubic centimeters of the soda solution, or sufficient to make the reaction strongly alkaline, and with a few pieces of granulated zinc.

The flask is at once connected with the condenser and the contents of the flask are distilled until all of the ammonia has passed over into the standard acid contained in the precipitating flask previously described and the concentrated solution can no longer be safely boiled.

This operation usually requires from 20 to 40 minutes. The distillate is then titrated with standard ammonia.

The use of the mercuric-oxide in this operation greatly shortens the time necessary for digestion, which is rarely over an hour and a half in the case of substances most difficult to oxidize, and is more commonly less than an hour.

In most cases the use of potassium permanganate is quite unnecessary, but it is believed that in exceptional cases it is required for complete oxidation, and, in view of the uncertainty, it is always used.

Potassium-sulphide removes all mercury from solutions and so prevents the formation of mercuro-ammonium compounds which are not completely decomposed by soda solution.

The addition of zinc gives rise to an evolution of hydrogen and prevents violent bumping.

Previous to use, the reagents should be tested by a blank experiment with sugar, which will partially reduce any nitrates that are present which might otherwise escape notice.

This method cannot be used for the determination of nitrogen substances which contain nitrate or certain albumenoids.

These methods of analysis are suitable to all spices and have been used with them. They are but a general process, however, and are dependent for their value on

uniformity in the way they are carried out and the manner in which peculiarities of proximate composition in different spices are considered in drawing conclusions; determinations of particular substances, such as piperine, require, however, modifications, which must be described when discussing the analysis of each separate spice.

The chemical composition of olive stones and cocoanut shells is about as follows:

Water, ...	5.63	6.15
Ash, ...	4.28	2.15
Fiber, ...	41.33	37.15
Albumenoids, . . .	1.56	1.25
Nitrogen, ...	.25	.20

BLACK PEPPER (Piper Nigrum)

1 Malabar
2 Acheen or Sumatra
3 Mangalore
4 Singapore
5 White, from Penang, with all three coats removed
6 White, with one coat removed
7, 8 Parts of spikes
9, 10 Fruit
12 Ovary with stamens
13 Stamens
14 Portion of spike
15 A flowering twig

CHAPTER IV.

BLACK PEPPER

FRENCH, *Poivre;* German, *Pfeffer;* Italian, *Pepe Nero;* Spanish, *Pimienta;* Portuguese, *Pimenta;* Cyngalese, *Gammaris,* Javanese, *Maricha;* Persian, *Filfil-Seeah;* Hindoostanse, *Gol-mirch.*

Pepper (Piper) Nigrum, a name employed by the Romans, and derived by them from the Greek word *peperi;* the Greeks in their turn must have derived it from the Hindoos. Botanically it is applied to the typical genus plant of the natural order *piperaceae.*

Of all the varieties of spices used as a condiment, pepper is the only one which grows on a climbing vine, and there is no kind of spice better known or more esteemed or more extensively used than pepper. Its consumption is enormous.

Black pepper is one of the earliest spices known to mankind, being of extreme antiquity. Choice spices and rare gums were among the precious treasures of the kings of Egypt more than two thousand years before the Christian era.

The history of its development from earliest times is well brought out by the account given in the Pharmacopœia. According to Fluckiger and Hanbury the spice was well known as early as the fourth century B. C. Arrian, the author of Periplus of the Frythrean Sea, which was written about A. D. 618, states that pepper was then imported from Barake, the shipping place of Nelkunda localities, which have been identified with points on the Malabar coast. To this spice, Venice, Genoa, and other commercial cities of central Europe are indebted for much of their wealth.

The caravan of trading Midianites, who purchased Joseph from his brethren and sold him into Egypt were bearers of "spices and balm" for the Egyptian market, and when the sons of Jacob were

making preparations to visit the land the second time to propitiate the lord of the realm, their father said to them: "Take of the best fruits of the land and carry down a little balm, and a little honey, spice, and myrrh, nuts and almonds."

During the palmy days of Egypt, when they embalmed all of their distinguished dead, precious gums and fragrant pungent spices were largely called into requisition. Even the Iraelites in their ritualistic worship held in such high esteem many of these rare gums and oils that their law forbade their use for any other purpose.

Pepper received mention in the epic poems of the ancient Hindoos. Theophrastus differentiated between round and long pepper, Diascarides mentioned long pepper, white pepper and black pepper, and Pliny, the naturalist, expressed his surprise that it should come into general use considering its want of flavor, and he states that the price of pepper in his time at Rome was nine shillings and four pence per pound, English money. Both he and Diascarides, as well as Hippocrates, write of the medicinal virtues of spices and of their use in medicine.

Pepper has been so scarce at times and so expensive that one pound was considered a royal present, and was used like money as a medium of exchange, while at other times its market value has been very low.

In its frequent mention by Roman writers of the Augustan age we are told that it was used by them to pay tribute. One of the articles demanded by Alaric, the daring ruler of the barbaric Visigoths in 410 A. D., of this conquered and greatly humiliated race was 3,000 pounds of pepper. During this dark middle age pepper was so costly that rents were paid in pepper corn, the amount being about one pound at stated times. Even now in places this custom still continues. It is not, therefore, surprising that during the first centuries of the Christian era the common black pepper was prized as highly in the city of Rome as its weight in gold. Black pepper is found in the East Indian Islands, among which may be mentioned the Malay Archipelago, Java, Sumatra, Rhio, Johore. It is also a native of

Siam and Cochin China, and it grows wild in the forests of Malabar and Travaneore. It is eultivated in some parts of the United States and in the West India Islands.

The early history of the pepper trade is similar to that of other Eastern spiees. The Duteh for a long time eonfined the cultivation of it to the Island of Java. To aeeomplish this they forced its cultivation with so much earnestness that they defeated their own purpose and a more enlightened system has prevailed for the past thirty years. Since it is no longer under government monopoly, and entire freedom is allowed in the raising of this spice, its eultivation has been greatly increased.

The king of Portugal contraeted with middlemen in each of his forts on the eoast of Malabar for an annual supply of 30,000 quintals of pepper, and bound himself to send five ships every year to export that amount. All risk was held by the middlemen or farmers "who landed it in Portugal." As a compensation for this risk, the middlemen obtained the priee of twelve dueats a quintal and had great and strong privileges: "First, that no man of what estate or condition soever he be, either Portingall or of any plaee in India, may deale or trade in pepper, but they upon paine of death whieh is very sharply looked into. And although the pepper were for the king's own person, yet must the farmers pepper be first laden to whom the Viceroy and other officers and Captains of India must give all assistanee, helpe and favour with watching same and all other things whatsoever that shall by said farmers be required for the safetie and benefite of the said pepper."

In faet, it was beeause the price of pepper was so high during the Middle Ages that the Portuguese were led to seek a sea route to India. After the passage around the Cape of Good Hope had been discovered, about 1496, there was a considerable reduction in the price of pepper, and when it began to be cultivated in the Islands of the Malay Archipelago, another reduction was made. It, however, remained a monopoly of the Portuguese erown for many years, even as late as the eighteenth century.

The earliest reference to a trade in pepper in England is A. D. 978-1016, when it was enaeted that traders bring-

ing their ships to Billingsgate should pay at Christmas and Easter, with other tributes, ten pounds of pepper.

Great Britain derived a duty from it for centuries, and as late as 1623 this duty was five shillings, or about $1.20 per pound. English groeers were known as " Peppers." Even in 1823 the duty was two shillings and six penee per pound. The pepper alluded to by Pliny at his time in Rome must have been the produet of Malabar, the nearest part of India to Europe, and must have eost in Malabar about 2d. per pound. It probably went to Europe by erossing the Indian and Arabian oeeans with the easterly monsoon, sailing up the Red Sea, crossing the desert, and then going down the Nile, and making its way along the Mediterranean. This voyage in our time ean be made in one month; at that time it probably took eighteen months. Transit and custom duties must have been paid over and over again and there must have been plenty of extortion. These faets will explain how pepper eould not be sold in the Roman market under fifty-six times its prime eost. Immediately previous to the diseovery of the route to India by the Cape of Good Hope we find that the price of pepper in the market of Europe had fallen to 6s. a pound, or 3s. 4d. less than in the time of Pliny. What probably eontributed to this fall in priee was the superior skill in navigation of the now eonverted Mohammedan Arabs, Turks, and Venetians, and the extension of their eommeree in the Eastern Archipelago, whieh abounded in pepper.

Black pepper was then for many years eonsidered a very choiee artiele and, like gold, silver, and precious stones, it was possessed only by persons of wealth, and was for generations found only on royal tables and those of the rieh and noble who aspired to rank with the rulers of the realm.

The British gave up the chief pepper ground of the world, which was the grand Island of Sumatra, to the Dutch for the small Dutch colony in Western Africa, whieh has involved both nations in little wars and has eost the Duteh more lives and moncy than it is worth; but prestige must also be sustained, and general after general returned with a shattered reputation from the

"Atyeh," as the Dutch called Achcen. When the East India Company first formed a settlement on the coast of Sumatra, it directed its attention to produce large growths of pepper. A stipulation was made with some of the native chiefs, binding them to compel their subjects each to cultivate a certain number of pepper vines, and the whole product was to be delivered to the company's agents at a price far below the actual cost of cultivation and harvesting. The chiefs for a long time enforced obedience to this arbitrary measure and their success in this was supposed to be permanently assured by granting them an allowance proportionate to the quantity of pepper delivered.

This arbitrary practice was too keenly felt by the natives to be endured, and, the influence of the chiefs soon declining and the people becoming negligent in the cultivation, the annual supply fell off. The chiefs, unable longer to maintain their despotic practice, abandoned to the agents of the company the task of obliging the people to labor that others might reap. Now the rights of the people are more respected and the injustice of the methods formerly used are fully acknowledged; the cultivation of pepper in Sumatra, as well as elsewhere, is free.

Perhaps the earliest writer to describe the extent of the cultivation of pepper was Linschoten. He speaks of its coming from Mala or Malabar, and his friend and commentator of pepper, Paludanus, enters into a long account of its medicinal virtues. "It warmeth the mawe," he writes, "and consumeth the cold slymenes thereof to ease the payne in the mawe which proceedeth of rawnesse and winde, it is good to eat fyve pepper cornes everie morning. He that hath a bad or thick sight, let him use pepper cornes with annis fennel seed and cloves for there by the mystinesse of the eyes which darken the sight is cleared and driven away." But in modern medicine it is very little used, being rarely prescribed except indirectly as an ingredient of some compound.

Black pepper is the dried fruit of the *piper nigrum*, a perennial climbing shrub indigenous to the forests of

Travancore, a native state in India, province of Madras, and of Malabar, a province of India, from which it has been introduced into the other countries mentioned.

Two species of piper will be found under drugs, "Cubebs" and a third falls within the range of the articled drugs "*Kava-Kava,*" and *Narcotics;* and two others are dealt with under "*Narcotics.*" There remain then for description as spice, black pepper, white pepper, long pepper, and Ashantee pepper.

In planting a new garden where no wild pepper vines are to be had, level land is selected which borders on a river or small stream without much sloping, but not so low as to be liable to any overflow from the stream, as the land must be kept well drained. Pepper is a hardy plant and will grow on almost any soil, but not on old, worn-out plantations or on poor sandy or clay soil, as more depends on the soil than on the cultivation. It should not be planted on hillsides because the earth will wash from the roots in time of rains. The best soil for pepper culture is a well-drained vegetable loam; swamp lands are very good in a hot climate with heavy rains.

The vine may be propagated either from the seed or by cuttings. When berries are selected for seed they are first soaked for three days, when the outer coat can be removed. The seed is then dried in the shade, after which it is sown by drills in nursery beds, which are made in the usual manner in good moist soil in a shady locality.

Frequent watering will be necessary, if it be a dry time, until the plants have four leaves, when they will be ready for planting.

The land to be planted is to be cleared of underbrush. Sometimes large trees are burned by setting fire to their trunks. The tree will then decay and will be attacked by insects and will become a heap of rotten dust. This dust is washed by the rain around the roots of the vines, making a good fertilizer.

The land cleared is next well planted and hoed and is lined out 7 x 7 feet, and holes are dug two feet square and fifteen inches deep, which are filled with good soil or leaf mold if it can be secured. In filling these holes they should not be heaped, as depressions are better for the

plant, but care should be taken that all that portion of the plant underground in the nursery should be buried in the garden.

The land is fenced by mud walls made into terraces. The vines need support, for if they are not supported they will spread over the ground with the result that there will be much loss of fruit.

When posts are used, as is the ease on the Island of Borneo, they should be twelve feet long and eight inches square, with the lower end tarred for two feet, to prevent decaying in the ground. The plantation will then have the appearance of a hop field. But there are many disadvantages in connection with the post support, as the posts must be reset at intervals (much oftener than the vines) and the removing of the post disturbs the aerial roots of the vine, which cling to them. Even if the vine be trained to its new post, it will take some time for it to attach sufficiently to receive any support or nourishment. As the poles furnish little or no shade, a severe drought will largely ruin the plants. For these reasons the use of posts has not proved a sueeess. Different countries use different growing trees for the support, thus securing shade protection as well. Many kinds of trees are used. One of these is the mango or the bread tree, which will yield the planter one erop of fruit each year in addition to the pepper crop; but the bread tree (*artocarpus-incioa*), being of slow growth, should not be used for a support until it is twelve years old. The Jaek tree (*artocarpus-integrifolia*) is sometimes used in Malabar as a second choice, but its fruit is diminished in quantity and quality by the pressure of the pepper, and sometimes the monkeys will pull them out or the crickets nip off the tops. The *erythrina-Indica* (*erythrina coroilodendron*), a thorn tree called by the natives *chingkariang,* is much used in Sumatra for an early support. It grows quickly and is easily started by simply stieking a large branch in the ground in the rainy season. It will be capable of supporting the vine in one year, but it will soon be killed by the growing vine, not lasting more than twelve years. For this rea-

son the mango or bread tree is planted beside it and when the *erythrina-Indica* tree dies out the first choice mango tree (*manganifera-Indica*) is ready to take its place and will furnish support for the vine for twenty years. Moreover, the fruit of the tree will not be affected by the growing vines. Plantations are set on the tilled land from July to August about twelve paces apart. In February and March the supporting trees are planted forty feet apart. They are kept well watered during the dry season, and when ten feet high are topped and kept trimmed or the leaves are picked off so as not to shade the plant too much. If the pepper garden is small, the vines may be planted near the trees already growing.

Plants raised from the seed in nurseries are transplanted in May or June, being placed in the prepared holes five feet apart with their root end from the tree and with the growing perennial vine top directed towards its support. The root should be as far distant as possible from the support. If the plants are of slow growth, manure may be applied to the surface of the ground. In China burnt earth and rotten fish are used. The land must be kept free from weeds and the plants must be kept well watered on alternate days in the dry season.

The pepper vines are trained to their support in October and November. They may begin to bear fruit the first year, but do not yield much until the third or fourth year. The hoeing, training, and fertilizing are kept up twice each year in October and November and July and August. The moist earth should be heaped up and well tramped down about the plant. When the vines are six feet high they will cling to the trees without further training. The vines will bear for about fourteen years and even thirty years sometimes in extra good soil, but when past fourteen years they will usually decline in vigor and fruitfulness. The vine, after topping, is from eight to ten feet long, but if left to grow its full length will be from twenty to thirty feet long and will go to wood and bear less fruit, and the fruit would be difficult to gather. When cuttings are to be used for plant-

ing, at least three should be plaeed in eaeh hole with six inehes under ground or four inehes above ground, the portion above ground to be direeted towards the support. The plantation is next eovered with leaves, dried grass, or weeds as a proteetion from the sun and to keep the earth moist and eool.

The vines grow rapidly if it is wet weather. When they have run up the support two feet, the ends are nipped off so as to eause lateral braneh es to start out. In some plaees, when the vines are from a year to eighteen months old and have grown five feet up the support, they are earefully detached and the ends, having been eoiled up in a spiral form, are buried in a hole dug in the ground close to its roots, except a small surfaee of the stem. This proeess is ealled letting down. It insures a large crop, producing seven or more vines to one supporting tree. Plants raised from euttings will only bear from seven to eight years, but the quantity and quality of the pepper is far superior to that raised from the seed.

The planting of the euttings in baskets is often earried on in the following manner: The cuttings, whieh are about eighteen ineh es long, are put half a dozen in a basket; at higher altitudes more are used, sometimes as many as ten or twelve. The basket is then filled with earth and is buried at the foot of the supporting tree, eare being taken that they do not toueh. In Oetober and November the ground around the baskets is dug up and the vines are manured with eow dung and leaves. The baskets are said to be a great proteetion to the young vines and they insure mueh better results. The end of the vine makes the best eutting, as it is a growing terminal bud. Vines growing wild, sueh as are indigenous to the forests of Malabar and Travancore, are left planted with the forest trees for their support. The surplus shade and underbrush are eut out and the ground is weeded, old vines being replaeed by young ones. The product raised in this way is about as good as the eultivated.

A pepper garden is generally planted with plenty of room for roads, so as to seeure easy aeeess to all parts

of it and with the least possible grade, which should not be more than one foot in twenty. The garden contains anywhere from five to fifteen aeres and is divided into plots by hedges of shrubs, each plot eontaining from five hundred to one thousand plants. The plants are pruned or thinned by hand as they grow bushy at the top, when the flexible stems generally entwine at the top of their support and then bend downward, having their extremities as well as their branehes loaded with fruit. It matters not how many stalks grow from the same root until the vine begins to bear fruit, but when fruit bearing begins only one or two stems should be left, as more would weaken the root and it would not, for that reason, bear as abundantly. All suekers and side shoots must be earefully removed. Trenches are eut to the neighbor props where the vines have failed, and through these trenches superfluous shoots are eonducted, where they soon ascend around the adjacent tree. By this means the plantation is of a uniform growth, and, since the ground is kept well weeded and is elevated, and sinee there is an open border of twelve feet wide around eaeh garden, there is given to the plantation an admirable symmetry and neatness of appearanee.

The pepper vine or climbing shrub is mentioned by Sir John Mandeville in his travels of 1322 to 1356 as follows:

"The pepper growethe in manere as doth a wylde vine that is planted fast by the trees of the woodee for to susteynen it by, as doth the vyne and fruyt thereof hangethe in manere as Reysinges; and the tree is so thikke eharged that it semethe that it wolde breke, and when it is ripe it is all grene as it were ivy berryes; and then men kytten them as men doe the vynes and then they putten it upon an owven and there it waxeth blak and crisp."

This simple description will in some respeets answer our purpose at the present time. The leaf of the pepper vine is entire, simple, alternate, without stipules, broad, and fleshy, or oval or heart-shaped. The leaves are arranged in clusters of five to seven in number, opposite the flower stalk, and the flowers, whieh are glossy-white,

HARVESTING OF BLACK PEPPER

COAST NEAR MANGALORE

are very insignificant in appearance upon a long slender pendulous spadix. They are for the most part unisexual, either manœcious or diœcious; that is, the staminate (male flower) and pistillate (female) flowers are separate either upon different branches of the same plant (manœcious) or upon different plants (diœcious). The leaves are four to six inches long, and they partake strongly of the aromatic and peculiar smell and pungent taste of the berry. The small fruit grows loosely on the pendulous fruit stalks or spikes. A single vine will bear from twenty to thirty fruit spikes and each spike contains twenty to forty berries. If they were allowed to ripen, the berries would lose some of their pungency and would gradually fall off.

The pepper vine produces two crops annually, the first in December and January, at the time of the first monsoon. The flowers of the second crop appear in March and April, at the time of the little monsoon, and the crop is gathered in July and August. The second crop is inferior both in quality and quantity, probably on account of lack of moisture.

The pepper berry is a small, round, sessile, fleshy fruit, which at first appears green, next red, and finally yellow when fully ripe. When one or two berries at the base of the spike begin to turn red the entire spike is pinched off.

In gathering the fruit, the natives make use of a small triangular ladder made of bamboo, with which they go around the tree and reach all the fruit as they go. The fruit is put in small baskets slung over the shoulder (see illustrations) of the gatherer. It is then taken by those who work on the ground to a smooth, level spot of clean, hard ground and spread on mats or platforms to dry (mat drying is said to give heavier returns), care being taken to carry it in at night so as to escape the dews. After three days, as the drying proceeds, the berries are removed by rubbing with the hands and are picked clean or winnowed in large round sieves. In some eastern localities mills operated by hand facilitate the work. After the berries have become dry they will shrivel and

turn black or chocolate. Those gathered too soon will after being dried become dust.

The berries after drying are spherical and about one-fifth of an inch in diameter and are wrinkled on the surface, indistinctly pointed below by the remains of a very short pedical and crowned by three or four lobed stigmas. The thin pericarp tightly encloses a single seed, the embryo of which, on account of the premature gathering is not fully developed and is replaced by the cavity below the apex. The seed itself contains within the thin red-brown testa a shining albumen of angular, radically arranged, large-celled parenchyme, gray and horny without and mealy within.

The transverse section of a grain of pepper exhibits a soft, yellowish epidermis covering; the outer pericarp is formed of a closely packed yellow layer of large and most radically arranged thick-walled cells, most of which are colorless and loaded with starch; others contain a soft, yellowish, amorphous mass, each containing in its minute cavity a quantity of dark brown resin, while the middle layer of the pericarp consists of starch and oil, the shrinkage of which causes the deep wrinkles on the surface of the berry. The next inner layer of the pericarp exhibits its circumference tangentially arranged soft parenchyme, the cells of which possess either spiral striation or spiral fibers, but towards the interior lose parenchyme free from starch and containing very large oil cells. The testa is formed in the first place of a row of small yellowish thick-walled cells, next to which follows the true testa as a dense, dark-brown layer of lignified cells, the individual outlines of which are indistinguishable. If thin slices are kept under glycerine for some time these masses are slowly transformed into needle-shaped crystals of piperine. The angular cells of the interior of the seed are, of course, the more prominent and, when once seen, their characteristic form and contents are easily recognized again. The structure of the outer coats is made out with more difficulty, and before attempting to do so on ground pepper it is best to soften some whole black and white pepper corns in glycerine and cut

sections from various parts of the exterior of the berry.

White pepper, since it is allowed to ripen fully, has the most distinctness, and, since it lacks the wrinkles, it will not be found difficult to pick out three layers of different cells from a section from it mounted in glycerine, composing the outer coat of the corn, besides angular large cells of the interior which are filled with starch and piperine, the latter being yellow in color. The first of these layers, the outer one, is made of colorless, large, loosely arranged cells with some fibers toward the exterior more compact than those toward the interior of the layer and carrying globules of oil. This layer makes up the principal part of the husk of the white pepper. The second layer is a part of what is generally called the testa and consists of small yellow cells, thick walled and closely oppressed. Next comes the third layer and second portion of the testa, which consists of lignified brown cells, which in their transverse appearance resemble some of the cells of mustard hulls. The individuality of these cells is not made out easily, owing to the thickness of the walls. After the observer has become thoroughly familiar with these appearances of the white pepper he should examine ground pepper, which will be found to differ in the way in which these coats are to be presented; they can be recognized, however, and must be studied until thoroughly understood.

The black pepper is not as simple in its arrangement as the white, the maturity of the white giving it distinctness, while the shrunken character of the black berry makes the recognition of its various tissues difficult. In a section from the exterior of a softened black pepper, the interior coats, after what has been learned of the white, will be quickly recognized, but they are not plainly developed. The coats of the outer pericarp, which in the white pepper were wanting, will be found to be darker colored, shrunken and confused, so that it requires much study to discover the forms of the cells, which may be more easily found in the powdered black pepper; there the structure already recognized in the ground white pepper will be seen and in addition dark-

brown particles, portions of the outer coats. Careful examinations of different particles will reveal some which consist of the elongated, vertical exterior cells containing resin, while others are the shrunken parenchyme cells of the second layer, whose structure is indistinct.

The colored portion of a ground black pepper divides itself into two classes, the dark particles which have just been mentioned and the deep reddish ones which are made up of the testa of the seed and its adherent parenchyme. The two will be readily recognized and distinguished from adulterants by investigation.

There are in all about forty different species of pepper plant, consisting of herbs, shrubs, and trees. They are generally named from the city or country of export. The differences in appearance of the product coming from various sources are sufficiently marked to be readily noticed when samples of each are at hand side by side, but otherwise it is almost impossible to distinguish between some of them. The goodness of the pepper depends more on the quality of the soil than on the cultivation, although cultivation will increase the yield. The fine Tellicherry pepper together with the Alleppy are considered the best varieties. Tellicherry is named from the city of Tellicherry of British India, province of Maladar, district of Madras. Alleppy is named from the city of Alleppy, which is the capital of the native state Travancore in the district of Madras. These are closely followed by the Malabar pepper from the district of Malabar, India. These varieties are sun-dried. Next comes the fine Penang pepper, named from the city of Penang, meaning "*betalnut*" (see illustration) in the Straits Settlement. This is followed by the Singapore, named from the city of Singapore, and meaning City of the Lion (see illustration), which is also in the Straits Settlement, and is the largest export city of spice in the world, being the center of export for spices grown in the Malay Peninsula as well as in Java and Sumatra and of that rich state known as Johore, in the southern extremity of the Malay Peninsula.

Singapore pepper, by reason of its dark color and

ACHEEN

TELLICHERRY COAST FROM OLD FORT, LOOKING NORTH

fairly uniform quality, is a good-looking pepper, and for that reason it is esteemed, but for grinding purposes it has not been heretofore so highly regarded, because of its smoky odor, as it is dried over smoke. The pepper plantation and the gambier plantation of Johore are usually under one management, and in boiling down the gambier to make the vegetable extracts there are suspended over the kettle mats on which are placed quantities of the Singapore pepper.

The smoke from the furnace dries and at the same time blackens the pepper and gives it the unmistakable smoky smell which is characteristic of Singapore pepper. This smoky odor is retained to a considerable degree after the pepper is ground, and it is one of the tests by which pepper merchants determine whether a given sample is Singapore or not. The Singapore pepper from Borneo is divided into, first, the Mullacca, which is the best and heaviest; second, the Caytongee; and third, the poorest sort, Negara, which is most abundant, and which is small and usually falls to dust. Mangalore pepper, named from the city of Mangalore (Fig. 3), is the largest pepper corn grown. It is nearly twice the size of ordinary pepper, is of a deep black color, very clean, and of uniform size. When ground it yields a powder of a characteristic greenish appearance. Lampong pepper takes its name from a district bordering on the east end of the Island of Sumatra near the Straits of Sunda where it grows. There is also a city in the district by the name, Lampong (meaning bobbing in water), where all the men and women meet at a central market house to transact their business matters. The Lampong pepper corns are less uniform in size than those of the other varieties before mentioned, and are also of a lighter color, and the surface contains much dirt. Acheen, Sumatra, or West Coast, are names applied to the pepper found on the great wild island of Sumatra, visited by Marco Polo in 1291. The island is divided into semi-independent states, each being ruled by its own prince or chief, who may be called Sultan, Rajah, or Datto. The interior of Sumatra is inhabited by the lion and the tiger, and by bands of savage Malays

mixed with Dyaks of Borneo and Hindoos, some of whom are very savage. Among these are the head-hunters, or cannibals, who impose as a penalty for certain crimes that the guilty one is to be cut to pieces and eaten, and sometimes is to be eaten alive. This class of people are found in the south of Achin.

Acheen pepper (Fig. 2) takes its name from the district by that name, or from the city of Acheen (native dialect, Atkeh) (see illustration) and the district of Acheen, which exported in the year 1904, 60,000 piculs (136 lbs. each); Telak Betang (South Sumatra) exported 50,000 piculs (136 lbs. each); Padang, Sumatra (meaning an open plain), produces much pepper of good quality, and the Bataks, of North Sumatra, have long been devoted to its cultivation. The designation East and West Coast, as formerly used, have been (as have also the three names it was known by on the island, "Iada-Iawor" or "Lampoon," "Iada Manna," and "Iada Jambee") lost track of, and the pepper is now designated according to its specific gravity as A, B, C, or D grade.

A grade weighs at least 4 lbs., 13 oz. to the imperial gallon (481 grams per liter).

B grade weighs at least 4 lbs., 5 oz. to the imperial gallon (431 grams per liter).

C grade weighs at least 3 lbs., 13 oz. to the imperial gallon (381 grams per liter).

D grade weighs at least 3 lbs., 5 oz. to the imperial gallon (586 grams per liter).

There has probably not been any of the A grade of Acheen black pepper in this country for several years, for the reason that it is this grade of pepper that is preferred by the manufacturers of Penang white pepper; and since it is used up in that way it does not reach our market except in the form of white pepper, Fig. 5. The best way to test the quality of the whole pepper is by weight, the heavier being the best. It takes 6,984 Singapore pepper corns (Fig. 4) to weigh one pound, while the finer grades of Tellicherry or Malabar (Fig. 1) require but 6,400.

CENTRAL MARKET LOMPONG (Bobbing in Water) TELAH BENTONG

A HOME IN ALLEPY

Pepper is sometimes graded by putting it in water, when the heavy sinks and the light swims; the water also removes the dirt that might adhere to it.

Shot pepper is the heavier black pepper put through a soaking and hardening process. Afterwards it is oiled to give it a better appearance, but as the water is injurious to the berry it is now generally separated in a column of air. The better appearance thus given to the shot pepper makes it more in demand and gives it a higher market value.

From what has been said, we can readily understand that the quality of pepper differs in the different localities. Pepper will hold its strength longer than any other spice. It has been found by mixing Malabar for weight, Penang for strength, and Sumatra for color, we get the most desirable powdered article. Malabar pepper has about twice the strength of Singapore, which has twice the strength of Sumatra. The Atjeh, Atchin or Acheen, pepper from the northeastern part of Sumatra, and that from the province of Batak in the more central eastern part of Sumatra Island, as received in this country, contain much earthy matter, and the East Archipelago pepper culture, including the islands of Jahore and Rhio, is so widely spread as to give us large and various qualities.

The city of Penang, in the Straits Settlement, exported in the year 1904, 53,613 bags of black pepper and 22,415 bags of white pepper, being about half of the entire supply, and the Island of Ceylon exported in 1904, 2,746 cwt. of pepper valued at $379.83. Saigon, China, has also many acres under cultivation. Of course, when the price of pepper is high, there is more profit for the grower, and the laborer is given more employment, since the acreage is increased. Advances of money are made to the Chinaman by the merchants, who take security on the growing pepper at a rate fixed much below its actual value. The Chinaman on this advance money erects a small building required as a home, and purchases his farming implements and has two dollars monthly for food and for opium, and at the end of the third year the plantation is equally divided

between the contracting parties. One man can take care of about 3,000 plants after they come into bearing.

Ashantee pepper or West African (and as it is sometimes called, African Cubebs) is the fruit of the piper, (Cubeb) " Clusii," and is principally from Niam-Niam, a district in Guinea bordering on the Gulf of Guinea in Africa, and is locally used as a substitute for black pepper, but has a hollow berry, much smaller and less wrinkled. In the southwest of India, where pepper grows wild, it is found in rich, moist soil, usually in narrow valleys. It propagates itself by running along on the ground and throwing off shoots every few feet. The natives, in caring for it, merely tie the ends of the vines to trees at distances at least six feet apart, and especially to those having a rough bark, as the vine readily clings to the rough surface of the tree. In India the berries of (Embelia) (Samara) Ribes are often mixed with pepper.

There is also a fruit called *Melegueta* pepper, known also as " Guinea Grains," Grains of Paradise, or Alligator pepper, which is the seed of *Amomum Mele Gueta,* a plant of the ginger family, which contains seeds which are exceedingly pungent and are used as a spice through Central and Northern Africa.

The cultivation of the pepper plant in the Western Hemisphere has been attended with fair success where it has been perseveringly pursued, but there is little probability that it can successfully compete even in the West India islands with that of those countries where the plant is indigenous. Jamaica pepper, which is a native of the Island of Jamaica, belongs more to the fruit of pimenta, an account of which is given under a separate chapter. The yield of pepper varies in different localities and may be from one and one-half to eight or ten pounds to a single vine. The third year the yield is one catty; fourth year, one and one-half catty; the fifth year, three and one-half catties, a catty being one and one-third pounds. Four thousand pounds is a good average to one acre. Ten pounds of green berries make only four to five pounds when dried and bagged for the market.

SINGAPORE (City of the Lion)

VIEW IN HARBOR OF PENANG FROM STEAMER LOOKING NORTHWEST

It is hard to estimate the amount of black pepper used each year, but it is very great. The United States consumes more spices pro rata than any other country. This fact is well known by exporters after long experience, and now many spices are shipped direct to the United States ports instead of by the way of London.

The chief use of pepper is that of a spice added principally to meats, but also to other food substances. Pepper is sometimes used for medicinal purposes, as it stimulates the stomach on account of the piperine it contains, and thus aids in digestion. In removing ringworms it has few equals. The native doctors of India consider it a stimulant, and they prescribe an infusion of the toasted berries in cases of cholera morbus; it will check violent vomiting in that disease when many other remedies fail. They also prepare a liniment from pepper which they think has sovereign virtue in chronic rheumatism. In Europe it is sometimes used as a stimulant in gout and palsy, and the watery infusion has proved a useful gargle in relaxation of the uvula. The dose of black pepper should be about six grains.

The chief enemies of the pepper vine are white ants, the black bug and white bug, the borer, male crickets, and the Cinchana caterpillar. A strong solution of tuba root is sufficient to keep away white ants, and tuba root mixed with juice of common tobacco will prevent the black and white bug work, and in mild cases ashes or sulphur and lime applied early in the morning will be found sufficient. The borer begins by attacking the joints of the branches and its presence is known by the light yellowish color of the bark. There is no known preventive for the borer, except to catch it before it has gone too far. It always works around the joints, and when it has completed the circle, it commences to bore down the center of the branch, and sometimes, but very seldom, the stem. The male cricket goes for the roots, but does the least damage; if it has gone too far to be dug out, the best way is to plug up its hole as far as possible with clay.

The green Cinchana caterpillar attacks the leaves only, but may destroy many of them; the only plan to

make way with it is to send a coolie around to collect and destroy the insects.

Whole pepper is seldom or never adulterated, although much is uncleaned. Old, water-soaked stock is at times found on the market. Several years ago two thousand bags were thrown into the Thames River from a wharf which was on fire, and was later offered for sale at auction. The powdered article, however, is adulterated more than any other condiment used as a table spice. The adulteration is made by almost any cheap, foreign article attainable and in a most ridiculous and not only unlawful but inhuman way. The probable reasons why pepper is selected for this more extensive abuse are found in the fact that adulteration is more easily covered up and in the further fact that, owing to the large amount of pepper used, the gain is much greater.

The quality of a ground pepper can be told by an expert from its weight and color, and on examination with a lens of low magnifying power. The particles are not coarsely ground, and it is not difficult to pick out pieces of husk, yellow corn, and rice; if necessary, a more careful investigation under a microscope of higher power will serve for confirmation. Black pepper is much more liable to be adulterated than the white, although it is perfectly easy to dilute the latter with broken rice or cracker-dust, or with long pepper. There is a disposition many times on the part of those who can afford it to have the best that can be made, in appearance at least, and it is thought by some that the whiter the color of the pepper the purer the quality. This is a great mistake. The removing of the outer covering of the black in order to make white pepper removes the most pungent part of the fruit. This work is sometimes carried so far that, while the fruit, when ground, is nearly as white as starch, there is little left but starch. It is questioned whether this practice is not as much an adulteration as the skimming of milk, as it takes away the most valuable part of the fruit. Long pepper is also used to adulterate pepper, but the taste and smell of the long pepper cannot be disguised, and its starch is

nearly double the size of that of ordinary black pepper. Not only are the pepper shells used to adulterate ground pepper, but also other by-products, such as middlings, wheat, corn, ground olive stones, cocoanut shells, almond shells, mustard hulls, long pepper, Cayenne pepper, sago, and linseed.

These are sold to the spice grinders under the name of "P. D." pepper. Pepper adulterants and pepper mixtures,— P. D., pepper dust; H. P. D., hot pepper dust; W. P. D., white pepper dust — consist of such products as the grinder has at hand or can obtain at the lowest price, the mixer requiring only that the colors shall be such as are suitable for his trade. In London, the olive stones are much used, put up in colors of both black and white. Pepper mixtures are sold under the name of "Poivrette or Pepperette." Their natural color is pale buff, much resembling the middle layer of the pepper berry when ground, and they cannot be distinguished from the pepper by the eye, even with the use of a hand lens, when mixed with a powdered pepper, but with the aid of the microscope with one-sixth or one-eighth objective, it is seen that they consist of pale, dense, lignous cells, being entire and marked with linear air spaces; some are torn and indistinct. Other substances examined showed finely ground clay and brick dust. The presence of pepper husks and charcoal is generally known by the immensely increased proportion of black particles in the field, as appears in Fig. 43, opposite page 25, Chap. III.

The true pepper powder, and one in which rice starch is present, is given in Fig. 21 and in Fig. 42, which also gives us an idea of the size of the pepper starch, which is very small as compared with any other kind of starch.

Much authority might be quoted on the adulterations of pepper, but enough has been written to give the reader an idea of its vastness. I will next endeavor to give the method of examining peppers microscopically.

First, the sieve examination of those particles left upon a forty to sixty-mesh sieve is of value. This examination will frequently reveal the nature of the adulterant or the too large portion of pepper husk.

Next, by the aid of a good dissecting microscope, fifteen to thirty power, the frequency of the occurrence of the coarse particles, after a little experience, will not be difficult to sort out, and the presence of sand or a notable excess of P. D. may be detected and estimated. Backgrounds of white and black with reflected light and afterwards transmitted light may be used in the manner so conveniently afforded by Zeiss's stand made for this purpose. A portion of the powdered pepper or the separated coarse particles should also be treated with a chloral-hydrate solution for twenty-four hours, to render it more transparent for examination with higher powers, and in the meantime a part of the coarse particles collected from the sieve may be examined under a one and one-half inch objective and then crushed and reexamined, using both plain and polarized light. In this way husky matter may be distinguished and foreign starches rejected. Polarized light is then the means of bringing out more plainly the starches, the proportion of which iodine will reveal. Due allowance should be made for the smaller granules of pepper starch and all optically active tissue, such as the fibers and sclerenchyma or stone cells, which are found in olive stones and cocoanut shells.

The chloral-hydrate preparation should now be examined, much of which disappears, and the starch is found much swollen. The structure of the pepper itself has already been explained and is supposed to be so well understood that it cannot be confused with the foreign matter, as the husky matter present is rendered so much clearer that its identification and differentiation are much easier. Experience with half a dozen samples of cheap, in comparison with a pure, pepper will soon teach one the best means of making out what has been briefly described.

It has been found most valuable to digest about a gram of pepper with nitric acid, specific gravity 1.1, and chlorate of potash for several hours, or until the color is bleached, when it is then possible to distinguish the denser cellular structure more easily than in any other way. This is particularly true of the stone cells, which make up the larger part of the cocoanut shells

and ground olive stones, especially when polarized light is used. Care should be taken not to confuse the stone cells of the pepper husk with those of olive stones or other adulterants. Charcoal at the same time remains unbleached. The analyst will find many variations in the samples met with and should always be on guard for something new.

Chemical composition of black pepper.— The analysis of the pure ground pepper shows the amount of water to be between 8 and 10 per cent., but, of course, it varies with surrounding conditions. The ash in black peppers does not exceed from 4-10 to 7-10 per cent., and in white, 1 4-10 per cent.; it is fair to believe that anything above 5 per cent. for black and 2 per cent. for white is suspicious. The volatile oil, to which pepper owes its flavor, varies in black pepper from 1.69 to .70, and in white 1.26 to .57 are found, but this determination is not of great value as a means of detecting adulterations.

Piperine, which is a neutral crystalline substance, and resin, to which the pepper owes its pungency, of which it yields about two per cent. in its composition, are similar to oil of turpentine as well in specific gravity as in the boiling point. These substances furnish a most valuable check on the purity of both white and black pepper. Pepper contains from 7.90 to 7.24 per cent. of these substances, showing a great constancy in amount, and on addition of adulterants, this is plainly affected, which seems better than a determination of pure piperine, which is difficult and causes much loss. It has also proved impossible to make determinations of piperine by the combustion, or K. Jeldahl, methods by application of Stutzer's copper-hydrate process, the percentage of nitrogen being so small, 4,912 in piperine, as to make the error very large when converting the former to the latter, the necessary factor being 20.36.

The determination of starch or its equivalent in reducing sugars has been looked into with care, and a preliminary extraction with alcohol and water is necessary to obtain results which are fairly constant, which determination shows black pepper to contain from 34 to 38

per cent. of starch, or 42 to 47 per cent. of substances of reducing sugar equivalent, calculated on dry ash free substance. White pepper contains in the same way from 40 to 43 per cent. starch and gives from 50 to 55 per cent. of reducing sugar equivalent on dry ash free substance.

The crude fiber in black pepper does not vary far from 10 per cent., but in the white pepper is much reduced, depending to a certain extent on the perfection of the decortication. Four to 8 per cent. are probably fair limits, and this determination is quite necessary in revealing the presence of foreign woody or fibrous matter.

Albuminoids do not vary widely, 10 per cent. being the average, with extremes of 7.69 and 11.50. The addition of nitrogenous seeds, of course, increases the amount, and of fibrous or woody matter diminishes it.

We have the following result as a standard:

Water,	8.0 to 11.0
Ash,	2.75 to 5.0
Volatile Oil,	.50 to 1.75
Pepperine and Resin,	7.0 to 8.0
Starch,	32.0 to 38.0
Crude Fiber,	8.0 to 11.0
Albuminoids,	7.0 to 12.0

CHAPTER V

WHITE PEPPER

WHITE pepper is thought by many to be produced by a separate plant, but it is the fruit of the black pepper vine, the change in appearance being brought about by artificial preparation. The poor natives are said to collect for market some white berries, which have been left on the vines until fully ripe and then have fallen to the ground and, by their exposure to the sun, have lost the outer black coating. That which remains is called the "genuine" white pepper. This collection of the white pepper corns by the natives has given rise to the story that a small bird called ballaree, feeding on the black pepper, digests nothing but the outer husks and, the balance, having passed whole through the organs of the bird, becomes white.

The pepper vines are injured by allowing the berry to ripen before gathering to make white pepper. For this reason the unripe fruit is often used, and some manufacturers make it a business to prepare or make the white pepper. The unripe black pepper is robbed of its outer coat, to make white pepper, in several ways, according to the extent to which the decorticating process is carried. Thus, we may have decorticated pepper from which all three coats are removed, or only one or two of them. All of these kinds are called factitious white pepper. Thus we have Tellicherry, which is particularly fine, and, second, the "coriander white," so called from its close resemblance to the seed of that name. This is also a fine grade. It is made in imitation of the coriander seed by cutting off from the end of each corn a piece of the outer hull, so that the dark-colored inner portion shows. The ordinary white follows next, which is made from the Singapore, Penang, etc. This is often bleached to imitate the first two, but it makes a sad imitation.

The Tellicherry and coriander are packed in cases of about 200 pounds, each with marked tare on every case. The ordinary white is packed in bags of about 150 pounds, with 2 per cent. tare, with an allowance of one pound to each package.

The process is as follows: The black pepper may be kept in the house for several days and then bruised or washed in a basket to remove the stalk and pulpy matter, after which it is dried in the sunshine before shipping. It is also prepared by steeping in water in which it has been allowed fully to ripen and then removing the outer coat by friction. The natives also remove the outer layer by placing the ripest red grains in running water or in pits made near the river bank or in stagnant pools. Sometimes it is only buried in the ground, and when it has been under this treatment for about one week it will swell and burst the outer husk, which is then easily removed by rubbing with the hands while it is drying in the sunshine. After being winnowed it is ready for export. Another way of preparing white pepper, often used, is to place the black pepper in a solution of chloride of lime water to remove the dark coating, after which it is rubbed and dried as in the other preparation.

Although the white pepper has the name of being a superior article, it is not. It is very true that only the marrow of the black pepper berries can be used to make white pepper, and the product does have an exquisite flavor; but since the greater strength lies in the outer cover, there is some doubt as to the quality of the white pepper. Moreover, the real goodness of the pepper is, in fact, not improved by this process, as the water injures its strength, the outer husk contains more of the aroma, and the quality of the pepper removed is almost proportionate to the weight of the pepper corn. The only gain obtained is in the appearance, and this process is but another way of meeting the public demand for something to please the eye, instead of the palate.

White pepper brings a higher price to the grower, but when the waste and extra labor are considered it is seen that the grower's profits are largely reduced.

White pepper corns allowed to ripen fully are larger than black and can be reduced to a powder more readily, and will present a more uniform appearance.

China and the Straits Settlement export much of the cheaper white pepper found in our market and much of it comes from the island of Rhio, and it is imported in the whole.

Chemical composition of white pepper:

Water,	8.0 to 11.0
Ash,	1.0 to 2.0
Volatile Oil,	.50 to 1.75
Piperine and Resin,	7.0 to 8.0
Starch,	40.0 to 44.0
Crude Fiber,	4.11 to 8.0
Albuminoids,	8.0 to 10.0

By mixing one part ground white pepper with two parts of slacked lime and a sufficient quantity of water, and evaporating the solution to dryness in a water bath, the powder being exhausted with commercial ether, piperine can be obtained nearly pure in large crystals of a faint straw color.

To obtain it perfectly pure, it must be dissolved in alcohol and recrystallized.

CHAPTER VI

LONG PEPPER

LONG pepper is the fruit spike of a wild plant of *Piper longum* (*Chavica Roxburghii*) and of *Piper* (*C. officinarum*), there being two species — French, *Poivre longue;* German, *Langer pfeffer;* Italian, *Pepe lungo;* Spanish, *Pimienta larga;* Javanese, *Chabi-Jawa;* Hindostan, *Pipel;* Cyngalesc, *Tipilie, elephant pepper;* Cochin Chinese, *Caylot.*

Long pepper (*Piper officinarum*) is a perennial plant and has oblong leaves attenuated at the base, and is a native of Indian Archipelago, Nepaul, and Java. It is found growing along the streams of the East Indies, Sumatra, Celebes, and Timor, and is also found in Malabar, Ceylon, and East Bengal, and in the Philippines, being indigenous to most of these countries. It is distinguished from the former by having cordate or heart-shaped leaves at the base, which are pinnate and five-veined.

In Bengal the plants are raised from suckers and are set five feet apart in rich, high, dry soil. Its stem is smooth with a slender branch and scandant leaves, cordate pointed and nerved, and of a deep-green color. The flowers are dicœcious and small, in short, dense, terminal solitary spikes, which are nearly cylindrical and opposite to the leaves. They are very similar to black pepper, with some characteristic differences.

Long pepper appears to have been known by the ancient Greeks and Romans, and in the tenth century mention is made of long pepper or *Macro-piper.*

The minute baccate fruit, which is closely packed around the central axis, is at first green, becoming red when ripe. The peppers are hottest in their immature state and are then gathered and dried in the sunshine, when they change to a dark gray color. They are imported in the spikes which have the appearance of being

LONG PEPPER (Piper Longum)

limed. They are about one and one-half inches in length by one-fourth inch thick, but vary in size and are indented on the surface. The yield from an acre is three maunds of eighty pounds the first year, twelve the second year, and eighteen the third year, after which the yield diminishes. The roots are finally grubbed up and dried and sold as "*pi pli mul*," which is a favorite medicine of the Hindoos, who use it for palsy and apoplexy. The infusion of the powdered fruit mixed with a little honey is said to be good in catarrhal affection, when the chest is loaded with phlegm.

In structure it does not bear a close resemblance to black pepper, as its pepper corns, or berries, and husks all harden together on a long, central, irregular, climbing stem, much in the same way that in the pines the seed and covering are all hardened into one cone. It not only has more woody fiber but brings with it much more sand, which is found imbedded in the crevices of the irregular fruit, than is found in ordinary pepper.

Long pepper is a spice often called for during the fall season for pickling. It imparts a flavor to pickles which causes a demand for it for preserving purposes. There is much old stock on the market, which is poor. This is often used to adulterate ordinary pepper, but it can be readily detected by its disagreeable odor, which warmth will develop, and by its slaty color and the amount of sand it contains. Although grinders try to destroy the odor by bleaching, and the slaty color by sifting out the husk to make it lighter, its characteristics cannot be covered up in the true pepper.

In gathering the long pepper, the native, being paid by the weight for what he brings to the market, takes care not to less the weight of dirt, but rather to increase it. and in consequence we find that it has always from 3 to 7 per cent. of insoluble sand and clay in addition to the proper ash of the fruit. It is impossible to clean it as pepper should be cleaned for grinding, except with difficulty and by hand.

The pepper is harvested in January and when thoroughly dry is put up in piculs of 135½ pounds each.

The ash of the long pepper contains a very large pro-

portion of salts insoluble in hydrochloric acid, and when ground the hard husk and woody centers, as well as the dirt, are neeessarily ground along with the minute berries. Although it contains more sand and more woody fiber than genuine ground pepper of the corresponding shade, it does not contain as much cellulose as the most husky black pepper.

Long pepper is always cheaper than the best black pepper and may be sold as long pepper on the market without offense, but it has no more right to a place on the market as black pepper than has any other admixture, and as such is as fraudulent as buckwheat meal and is just as objectionable.

A sure test for long pepper as an adulterant in ground black pepper is to heat a piece of cold meat between two plates and sprinkle some of the suspected fresh long pepper on it, when the smell and flavor will be so offensive that one will feel obliged to reject the meat.

The presence of long pepper may be determined by the following characteristics:

1. If much long pepper is used, its peculiar slaty color will show, although sifting and bleaching will partly hide the color; but the odor of the mixture when warmed is unmistakable to an educated olfactory sense, even if the amount of mixture be moderate. The odor cannot be destroyed by bleaching, for that has been tried, and even the ethal as well as the alcoholic extracts from which the solvent has been evaporated at a low temperature yields, when warmed, the characteristic odor very plainly. Admixture of long pepper would also introduce much sand in the powdered black pepper, and in white pepper it would be much more noticeable, as white pepper does not contain 2½ per cent. of sand and more would mean an admixture. There being also much woody matter in powdered long pepper, arising from the smallness of the berries as well as the hardened setting and from the central woody tube, this may be detected either by chemical analysis or by microscope, and some of it by the naked eye or with the aid of a large hand lens. If the sample be spread out in a smooth, thin layer on strong paper by

means of an ivory paper knife, pieces of fluffy woody fiber will be detected, especially if the thin layer be tapped lightly from below. These pieces come from the central part of the indurated catkin, which cannot be completely ground fine as genuine pepper stalks are ground. Much of this matter is removed by the grinder's sieves, but enough pass through the meshes of the silk to be useful as a corroborative indication, and if any particles of husk pass through they can be told from those of the genuine pepper husks.

A proportion of the starch granules of long pepper is of larger size, about .0002 inch, and of angular shape, very slightly smaller than rice granules and more loosely aggregated in clusters or isolated. Here it is necessary to notice that the statement is made in books that genuine pepper starch is round in form. Pepper starch is doubtless round in the main, but not invariably. (See illustration.) The loose granules of the interior are spherical, but in the dense portions of the berry they become more angular by pressure on each other.

Chemical composition of long pepper:

Total ash,	8.91
Sand and ash matter converted into sugar, H. C. L.,	1.2
Total matter soluble in 10 per cent. of H. C. L.,	67.83
Starch and matters convertible into sugar,	44.04
Albuminous matter soluble in alkali,	15.47
Cellulose,	15.70
Extracted by alcohol,	7.7
Extracted by ether,	5.5
Nitrogen,	2.1

Long pepper also contains piperine, resin, and volatile oil.

The principal cities of export are Singapore and Penang, the annual amount of export being from 2,000 to 3,000 piculs of 135½ pounds each from each city at a London market value of 37 to 45s. a cwt.

CHAPTER VII

CAPSICUM, OR CAYENNE

CAYENNE pepper, Guiana pepper, Spanish pepper, Mexican chilli, as it is often called, more commonly spoken of as red pepper, is a genus of herbs or shrubs of the nightshade family (*Salanaceoe*) the fruit of any species of capsicum. The name capsicum is of uncertain origin, perhaps from kato, to bite — all of them having a strong, pungent flavor, or from *L. capso,* box or chest, from the shape of the fruit; the latter name being given to it by Broconna.

ANNUUM HERBACEOUS OR SUFFRUTESCENT

The true peppers are members of a totally distinct order, the *Piperaceoe.*

French, *Piment or Corail des Jardins Poivra d'Inde* or *Guinee;* German, *Spanisher Oderkerscher Pfeffer.*

Cayenne takes its name from the city of Cayenne (Koyen or Kien) (see illustration), or from the island and river, both of same name, on which it is located, or from the province of Cayenne in French Guiana, South America. The city of Cayenne is a French penal station, and exports large quantities of Cayenne, which we call Guiana pepper.

Probably the first known history of Cayenne pepper in Europe is that given by Martyr, who writes of Columbus bringing it home with him in 1493, and speaks of it as being more pungent than that from Caucasus, probably referring to the Oriental black pepper. About a century later, Gerarde writes of its being brought into Europe from Africa and Southern Asia and being grown in European gardens. Probably the first record of its use is that given by Doctor Chauca, who was physician with Columbus's fleet in 1494, and who alludes to it as a condiment used in dressing meats, dyeing, and other purposes, as well as a medicine.

CAPSICUM OR CAYENNE

1 Zanzibar
2 Bombay
3 Sierra Leone
4, 5, 6 and 7 Common Garden

Cayenne pepper is supposed to have first been brought to America by the Portuguese, who found it growing in a wild state. Our greater supply now comes from Zanzibar, Nepaul, Bombay, and Penang.

Almost every gardener knows the red pepper plant. The plants are generally started in a nursery or hot-house in early spring, from the seed, and are transplanted when a few inches high, as soon as the weather will permit, in the prepared garden, about four feet apart. When about six inches high, a little rich fertilizer should be worked in the soil about the plants. The Cayenne pepper plant is an annual and is a slow grower, and it seldom rises higher than four feet. It has a rough stem, nearly globulous, with branches diffused and often scandent; the leaves are lanceolate, quite entire and repand, small, smooth, petioled, alternate in pairs or near each other, greenish white flowers, seldom violaceous; solitary or in twos and threes with rotate five, rarely six or seven, cleft corrolla; stamens, five, and rarely six or seven, with five bluish anthers (connivent and dehising longitudinally) and an obtuse stigma, calyx usually embracing base of ovary, which soon becomes a pod, consisting of a fleshy envelope at first and afterwards a leathery, oblong, linear, juiceless pod or fruit, in which are the spongy pulp and seeds. These fruit pods are of several varieties, varying in shape and color, and being long or short, podded and oval, round or heart-shaped. The pods are bright red or yellow, divided into two or three cells full of small white seeds, known as pod pepper. The pods which are of a green color, when full grown, commence to change first to a lovely canary yellow and then to a rose pink, and so on through the different shades until they are intense scarlet when ready for harvesting in August and September (see illustration).

Don gives a list of thirty-three varieties in his General System of Gardening and Botany, which are used to make Cayenne pepper, but there are ninety different species of capsicum known, and ranging in height from a small plant of six inches to ornamental plants six feet in height, and of many varieties or species

of capsicum two contribute to that found in eommerce.

The *C. frutescens* of the *Fastigiatum* (perennial) sometimes reaehes to a height of several feet with branching and spreading tops, sometimes decumbent, leaves broadly ovate, fruit of various shapes and colors, usually small and very pungent, borne on long peduncles and is the speeies which is officinal in both the British and United States Pharmaeopœias. It grows in tropical Africa and America and is called Zanzibar pepper, and often by the name of Mexican chillies, and is of a high grade of Cayenne (Fig. 1). Its pods are very small, being from one-half to three-fourths inch long and very bright red, containing white seeds, the skin of the pods being tender and very pungent. The color of its powder is lighter yellow than *C. annum,* has a fibrous root system. Potato and tomato belonging to the same family, it is found growing in the United States and Europe and has been growing in English gardens since 1548 and, although indigenous to South America, is now cultivated in India, Hungary, Italy, and Turkey.

Nepaul capsicum (or Nepal and Nipal), as it is sometimes called, has an odor and flavor resembling orris and a pod the color of amber when dried. It is most esteemed as a condiment, being aromatic and appetizing, and not so acrid or biting as is most Cayenne. It is found cultivated on the mountain side in Hindoostan.

Cayenne of the African variety comes from Sierra Leone in the east and from Natal, southeast of Cape Colony, including Zululand and Tangaland, or from a territory that has a coast line of 300 miles. It grows to a height of five or six feet producing long, kidney-shaped, orange-colored pods. It is shipped from the port of Natal. It is considered the best for fluid extract. That from Sierra Leon (Fig. 3) has pods that are small, conical-pointed, and less than one inch in length. It is very pungent, and when reduced to powder is a light brownish yellow with a peculiar odor and somewhat aromatic. It is stronger in the powder than in the dry fruit, and to the taste is bitterish, acrid, and burning, producing, a fiery sensation in the mouth, which continues for a long

CAYENNE

time. There is a new Cayenne on the market of recent date, called Mombassa, from the city of the same name in Africa.

Bombay Cayenne (Fig. 3) has large pods, from two to three inches long, which when dry become flat in shape and of a pale-red color. It is not so fine flavored or pungent as the Zanzibar and is of less value.

The true Mexican chillies are grown mostly in Frantera de Tabasco, Mexico, the name being much used for Cayenne chillies from other countries, as has been mentioned.

The smaller varieties (*C. baccatum*) have been known in the English gardens since 1731; plants, small and very erect, and slender branches, fastigiate, flexous; corolla, small, spreading about one-half an inch, and has a globular fruit called cherry or berry capsicum, and are usually known as the "chillies" or "bird pepper." They are not more than one-half to three-quarters of an inch while the *C. annuum* is two to three inches long.

C. fastigiatum (*minimum*) which is usually termed the shrubbery capsicum and by Rheede is called *capo-malago,* is found growing wild in South India and is extensively cultivated in tropical Africa and America. It is three to six feet high with prominently angled or somewhat channeled stem and loosely spreading or trailing branches; leaves broadly ovate and acuminate, three to six inches long and two to three and one-half inches wide; peduncles, slender and one to two inches long in pairs, usually longer than the fruit; calyx, cup-shaped, embracing base of fruit; corolla, often with acherous markings in the throat; fruit, red, obtuse or oblong, acuminate, three-fourths to one and one-fourth inches long, and one-fourth to three-fourths of an inch in diameter, and very acrid.

C. annuum (*Longum crossum*), bell-shaped, of Algeria, which are often spoken of as herbaceous, and by Rheede as *vallia capo-malago,* the difference being chiefly in the nature of the stem.

It is two feet high with few branches and very large leaves, often three to five inches long, and sometimes caricous, lower ones usually pendant petioles, deeply

channeled; peduncles, about one inch long; corolla, large and spreading seven-eighths to one and one-fourth inches; fruit, large, oblate, oblong or truncated, three to four-lobed, usually with basal depressions, more or less sulcate and rugose; flesh, thick, firm and mild flavor.

The Minimum in Hindoostan is named "Dhan Nurich." The *C. grossum* bears fruit as large as a small apple and is called by the English in India coffrie chillie. It is preferred for pickling, the seed being first removed. The skin is fleshy and tender.

C. fasciculatum has few branches and clustered leaves or crowded in branches about the summit, elliptical, lanceolate, pointed at both ends; fruit clustered erect, slender, about three inches long, one-fourth inch in diameter, very acrid and is the red cluster pepper.

Acuminatum (*C. chilense*), herbaceous, very branchy, about two and one-half feet high, becoming a dense mass of foliage; flowers, medium size, spreading one-half to three-fourths inch; fruit, larger than *C. fasciculatum*.

C. cerasiforme has leaves medium ovate, oblong, acuminate, about one and one-fourth to three and one-half inches long; calyx seated on base of fruit; corolla, large and spreading seven-eighths to one and one-half inches; fruit, one-half to one-eighth inch thick, spherical, subcordate, oblate or occasionally obscurely pointed, or slightly elongated, smooth, or, rarely, minutely rugose or sulcate; extremely pungent, and cherry yellow.

Tetragomum, or bonnet pepper, is a species much-esteemed in Guiana, which bears very large, handsome, fleshy fruit, two colors, scarlet and golden yellow; and *C. frutescens* (spur or goat pepper) has been growing in the English gardens since 1856, is said to yield most of the Cayenne pepper which comes from the West Indies and South America; largely used in salads.

A kind called tobacco pepper is said to possess the most pungent properties of any of the species. It yields a small red pod generally less than an inch in length, and is longitudinal in shape, mostly borne above the leaves, and is so exceedingly hot that a small quantity of it is sufficient to season a large dish of any food.

Owing to its oleaginous character it has been found impossible to preserve it by drying, but by pouring strong boiling vinegar on it a sauce or decoction can be made which will possess in a concentrated form all the essential qualities of the vegetable, a single drop being enough to flavor a whole plate of soup or food.

The chilli plant is the Lat-tsiao of Cochin Chinese. It is constanly found in its wild state in the eastern islands. These varieties are enumerated by botanists; their fruits differ in degrees of pungency. All capsicum is a low grade of Cayenne. It requires but the simplest culture, and cultivation appears to increase the size of the fruit, but it diminishes its pungency.

Several varieties of *C. annuum* have little or no pungency. One of these is abundantly grown in Austria-Hungary, from which we obtain Paprika of the Magyars. Another kind is imported into this country from Spain in a powder for feeding birds to improve the colors of their feathers and to make them sing.

There are growing in the botanical gardens of Calcutta six species of capsicum, viz, *annuum, grossum, frutescens, baccatum, purpureum, and minimum.* The *grossum* in Hindoostan is called " Kaffrie Murich " and of the *frutescens* there are two varieties, the red and the yellow, called by the Bengalese " lall-lunka," " Murich " and " huldi-lunka " Murich. The Cyngalese name for frutescens is Casnairis. There is said to be a black pod as well as a red and yellow known on the Island of Ceylon.

The consumption of chillies in India is immense, as they are used by both rich and poor and constitute the principal seasoning for the poor in their rice. The natives of the West Indies, Africa, and Mexico use them very extensively.

West India stomachic man-drum is prepared by washing a few pods of bird's pepper and mixing them with sliced cucumber and shallots, to which add a little lime juice or Madeira wine.

A great quantity of agri or Guiana pepper is grown in Peru, a variety which the natives are very fond of as a condiment. It is not uncommon for an American

Indian to make a meal of twenty to thirty pods of capsicum and a little salt and a piece of bread washed down with chica, their popular beverage.

The wort, or Cayenne pottage, may be termed the national dish of the Abyssinians, as that, or its basis, "dillock," is almost always eaten with their ordinary diet. Equal parts of salt and well-powdered red Cayenne pod are mixed together with a little pea or bean meal to make a paste which is called dillock. This mixture is made in quantities at a time, being preserved in a large gourd shell, generally suspended from the roof. The wort is merely a little water added to the paste, which is boiled over the fire with the addition of a little fat meat. More meal is added to make a kind of porridge, to which sometimes are also added several warm seeds, such as the common cress or black mustard. Sometimes the larger peppers are harvested when full grown, while yet green in color, to be used for mangoes by removing the seeds and stuffing with chow-chow pickles. Cayenne may be considered one of the most useful vegetables in hygiene as a stimulant and auxiliary in digestion and has been considered invaluable in warm climates. It is used medicinally for various ailments in form of tinctures, as a rubefacient and stimulant, especially in case of ulcerated sore throat and also dropsy, colic, and toothache; when mixed with honey and applied externally is a good remedy for quinsy. It is also used for tropical fevers, for gout and paralysis. It acts on the stomach as an aromatic condiment and when preserved in acetic acid it forms chilli vinegar. When the seed of the chillies or capsicum is fresh it has a penetrating, acrid smell, and this irritant property which prevails obscures the narcotic action. Its acridity is owing to an oleaginous substance called capsicine, and this extremely pungent principle produces a most painful burning in the mouth. Capsicum or chillies is generally imported in bales of 130 pounds each and occasionally is bottled in vinegar when green or ripe. In the large factories a special mill is usually reserved for powdering Cayenne exclusively, instead of burr-stone mills with the ordinary shaking sifter. A high-speed iron plate mill is often

PUBLIC BUILDINGS, BOMBAY

A MADRAS FAMILY

As the children marry, they build an addition to the old home

used, and in connection with this a large revolving reel is required for sifting the spice as it is ground. The coarse part or tailings are returned to the mill automatically by means of a suitable, connected-bucket elevator. A special grinding outfit of this kind can be arranged so that it does not require much attention from the workman, a device which is very essential, as the fine powder works into the skin and great care must be used in handling the goods. Small grinders prefer to buy it powdered from the large factories. Sometimes the powdered Cayenne pepper is adulterated by mixing with wheat flour and made into cakes with yeast and baked hard like biscuit, then they are ground and sifted.

The pericarp consists of two layers, the outer being composed of yellow, thick-walled cells; the inner layer is twice as broad and exhibits a soft, shrunken parenchyma, traversed by their fibro-vascular bundles. The cells of the outer layer are especially the seat of the fine granules of coloring matter, which contain a fat or oily substance, as may be found if they are removed by alcoholic solution of potash.

The structural details of this fruit afford interesting subjects for microscopical investigation. The peculiarities described are so distinctive that the presence of foreign matter is easily detected. The cells of the pericarp or epidermis are of a peculiar flattened and chain-like angular form, which are characteristic of Cayenne. The other structures are not as prominent, but are not liable to be confounded with those of any adulterants. Diagrammatic representatives of this structure are given in Fig. 45, Chap. III, and the appearance of the pure ground Cayenne under polarized light in Fig. 44.

The portions of the seed in the powder are not readily distinguished without careful examination. They are, however, characteristic and contain starch, the form of which is shown in Fig. 20, Chap. III. The adulterants used are mineral coloring matter to hide the loss of color, which takes place on exposure of Cayenne to light, and for added weight ground rice, tumeric, husk of mustard, etc. Rice and corn flour adulterations are shown in Fig. 45, which cannot be confused with the few starch

grains found in the lower layer of the pericarp or in the seed. The tumeric and mustard are recognized by their peculiar structure.

The chemical composition of capsicum is (1) a fixed oil without sharp smell or taste and which is almost entirely in the seed; (2) a camphor-like substance which tastes and smells sharp, and which contains the peculiar principle of Cayenne (*capsicine*); this principle is found both in the pod and in the seeds, but in greater quantity in the pod; (3) a resinous body, the red coloring matter (capsicum red), which is found only in the pod.

In the detection of the adulterations of Cayenne by chemical methods, determination of water and ash, ether extracts and albuminoids are of value, and as a rule when combined with a microscopic examination will reveal the means and amounts of adulterations without difficulty.

Chemical composition of *Capsicum annum,* water at 100 degrees:

Water at 100 deg.,	Seed, 8.12	Pod, 14.75	Whole Fruit, 11.94
Albuminoids, . .	Seed, 18.31	Pod, 10.69	Whole Fruit, 13.88
Fat (ether extract),	Seed, 28.54	Pod, 5.48	Whole Fruit, 15.26
Nitrogen, free extract by difference,	Seed, 21.33	Pod, 38.73	Whole Fruit, 32.63
Crude Fiber, . .	Seed, 17.50	Pod, 23.75	Whole Fruit, 21.09
Ash, ...	Seed, 3.20	Pod, 6.62	Whole Fruit, 5.20
Total, ...	97.00	100.00	100.00
Nitrogen, . . .	2.93	1.71	2.22

PIMENTO OR ALLSPICE

1 Garden Allspice 2 Wild Allspice

CHAPTER VIII

PIMENTO, OR ALLSPICE

WHAT'S in a name? That which we call allspice by any other name would have as fine a flavor.

Pimento officinalis (*Myrtus Eugenia pimenta*), an order of Jamaica Pepper (*Icasandria Monogyia*).

Pimenta vulgaris myrtaceae. (These are names applied to the immature fruit of *pimento.*)

Spanish name, *Pimento.*

French, *Piment des Anglais Toute epice Poivre de la Jamiaque.*

German, *Nelkenpfeffer, Nelkenkopfe, Neugewurz.*

The pimento tree belongs to the myrtle family and is one of the most beautiful trees known as an evergreen. It grows to a height of from twenty to thirty feet and occasionally it reaches a height of forty feet. It is slender, straight, and upright, with many branches at its top. The trunk is covered by a smooth, gray, or ashen-brown aromatic bark which peels off in flakes as the tree grows. The leaves are opposite, stalked from four to six inches long, and are oblong, lanceolate, and somewhat tapering. The petioles are blunt and rather emarginated at the apex, and entire, smooth on both surfaces, with deep green, pale, and minute glands, dotted beneath, with the midrib prominent. They are particularly aromatic when fresh, abounding in essential oil which is the aromatic property of all kinds of fragrant fruits.

This tree is a native of the West Indies, and is found most abundantly on the limestone hills on the Island of Jamaica. It is the only common spice having its origin in the New World. It is found, but not in abundance, in most of the West India Islands, as well as in Mexico, Costa Rica, and Venezuela. It takes it name, pimento, from the Spanish word for pepper. This name was

given to it by early explorers of the New World because of its resemblance to pepper corn. It is called allspice because of the combination, or of the supposed combination, of various flavors.

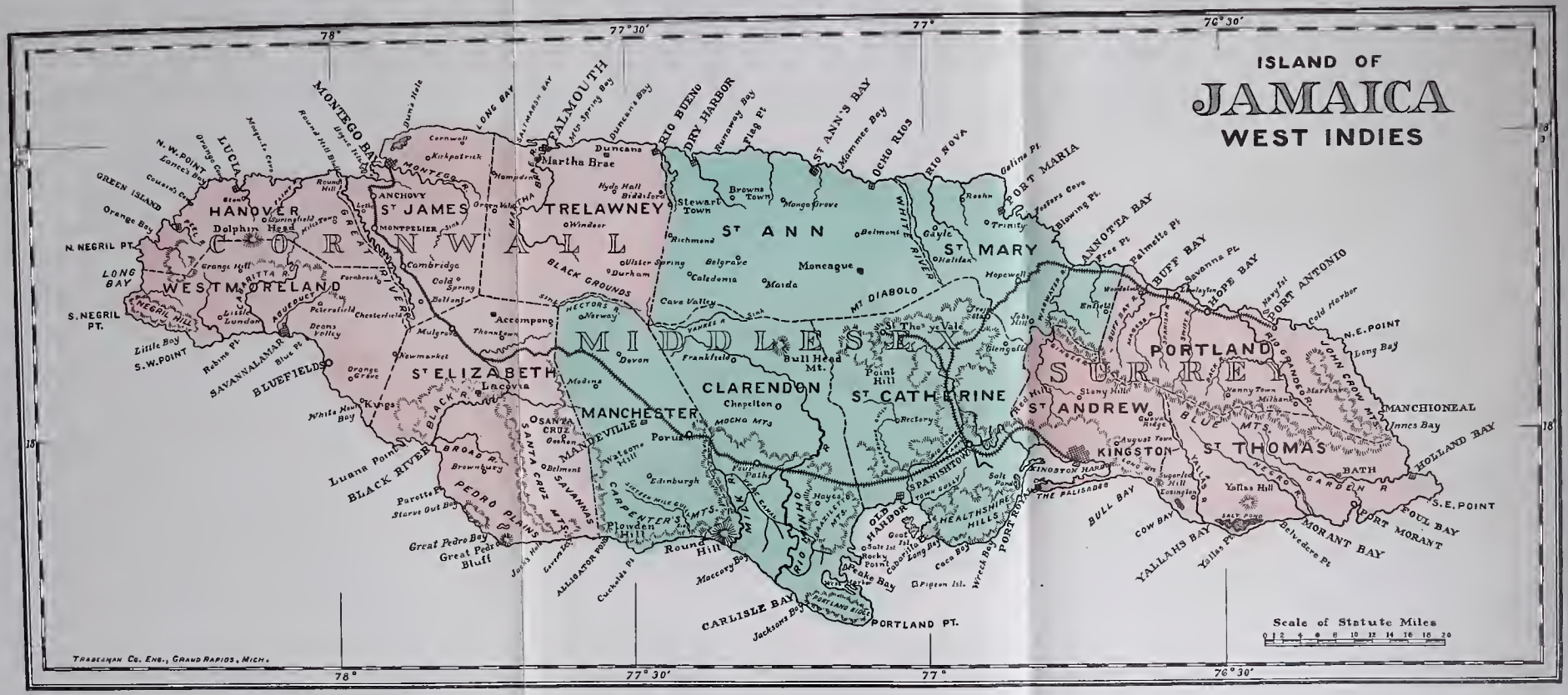
Some writers have claimed that it is a child of Nature, and that it defies cultivation, but this is a mistake, as may be seen by comparing the illustrations of the garden berry (Fig. 1) with those of the wild berry (Fig. 2). It is seldom cultivated, however, and it is found at its best growing wild 6,000 feet above the sea and very near the coast line, on a poor rocky lime or chalky soil, with a very shallow surface mold.

The tree will not do well in a clay or sandy or marshy soil, but the soil must be kept well drained, and a hot, dry climate is the best. Since the pimento seeds are scattered by birds, the trees are found in greater or less numbers in many parts of the Island of Jamaica. They sometimes are found in groups of from five to twenty, and again in great forests. It is the predominating tree on the island and is seldom found alone.

After the tree has obtained a certain growth the underbrush and other wood, with some of the pimento trees, are cut out, leaving the trees from twenty to twenty-five feet apart, as they will not yield so well if left closer. It is in this way that the beautiful pimento walks (Pi-men-to-wak) are formed which we read of in Jamaica.

The pimento tree flowers twice each year, in July and April, but it bears only one crop annually and begins to bear when three years old, and arrives at maturity at seven years, when it abundantly repays the patience of the planter.

In July the tree is covered with small greenish-white fragrant flowers of four reflected petals. The flowers are in bunches or trichotomous panicles at the extremities of the branches with a calyx divided into four roundish segments. The filaments are numerous and longer than the corolla, spreading, and of the same color as the petals, supporting roundish white anthers. The style is short and single and erect with an obtuse stigma. As the tree branches symmetrically, and has a very luxuriant


ISLAND OF
JAMAICA
WEST INDIES
78°
77° 30'
77°
76° 30'
18°
HANOVER
ST JAMES
TRELAWNEY
ST ANN
ST MARY
PORTLAND
ST THOMAS
KINGSTON
ST ANDREW
ST CATHERINE
CLARENDON
MANCHESTER
ST ELIZABETH
WESTMORELAND
CORNWALL
MIDDLESEX
SURREY
MONTEGO BAY
LUCEA
SALTMARSH BAY
FALMOUTH
DUNCANS BAY
RIO BUENO
DRY HARBOR
ST ANN'S BAY
OCHO RIOS
RIO NOVA
PORT MARIA
ANNOTTA BAY
BUFF BAY
HOPE BAY
PORT ANTONIO
MANCHIONEAL
HOLLAND BAY
GREEN ISLAND
N. NEGRIL PT.
LONG BAY
S. NEGRIL PT.
S.W. POINT
BLUEFIELDS
SAVANNALAMAR
BLACK RIVER
LUANA POINT
GREAT PEDRO BAY
GREAT PEDRO BLUFF
PEDRO PLAINS
SANTA CRUZ MTS.
CARPENTER'S MTS.
BLUE MTS.
HEALTHSHIRE HILLS
CARLISLE BAY
PORTLAND PT.
OLD HARBOR
BULL BAY
COW BAY
YALLAHS BAY
MORANT BAY
PORT MORANT
S.E. POINT
EOUL BAY
Scale of Statute Miles
0 2 4 6 8 10 12 14 16 18 20
TRACEMAN CO. ENG., GRAND RAPIDS, MICH.

foliage, its rich green leaves and profusion of small white flowers give a very handsome appearance. The air is freighted with its fragrance for quite a long distance, and every breeze which disturbs its branches conveys the delicious odor.

The fruit which appears soon after the blossoms, is a smooth, glossy, succulent, globular berry, from two-tenths to three-tenths of an inch in diameter, or about the size of a small pea.

Planters do not allow the berries to ripen fully, because in that case they would be difficult to cure and would become black and tasteless, losing their aromatic property. When the berries have their full size in the month of August, though yet green in color, they are gathered.

The harvesting is done by hand, by breaking off the twigs and stems which bear the berries. These are placed on a raised wooden floor or terrace to dry on mats for from seven to twelve days in the sunshine. Great care should be taken to turn them, so as to expose them fully to the sun, to prevent their quality being injured by moisture. Some planters dry them in kilns.

The one who removes the berries from the trees keeps three persons busy gathering them below, who are usually women or children. Care must be taken to separate, as far as possible, all ripe berries from those which are green, as otherwise the crop will be made of inferior quality. The fruit, which necessarily ripens on the tree, before the bulk of the crop is harvested, falls to the ground and is of no commercial value, as it has lost its aromatic properties. The problem which the planter has to contend with of harvesting his crop before it ripens is a serious one, for the harvesting often must be done rapidly, and it is often difficult to obtain help enough among the indolent natives to pick the crop. Thus many thousand pounds often go to waste. In wet weather the system of smoking is sometimes adopted for drying. The proper degree of dryness is ascertained by the wrinkled appearance and by the dark or reddish-brown color of the spice and the rattling noise made by the seeds when they are shaken. When the

berries begin to dry they are frequently laid in cloths to preserve them from the dews. They are exposed to the sun's rays every day and removed under cover every evening until sufficiently dry. They lose one-third of their weight in drying. The breaking of the branches in gathering the fruit answers to a rude kind of pruning. The crop is very abundant, some trees yielding as high as 150 pounds of green or 100 pounds of dried berries.

Pimento is exported chiefly from Kingston, Jamaica, in 120 to 130-pound bags. About one-third of the crop comes to the United States; most of the balance goes to England, whence it is exported to other countries. The pimento del tobasco tree, a native of Mexico, produces a larger berry than the true pimento, but it is less aromatic and is often used to adulterate the allspice of commerce, but the true pimento is so cheap that it is adulterated but very little. The pimento is ground on common burr stones. It is used for medicinal purposes to prevent the taste of nauseous drugs, and it stimulates and gives tone to the stomach. It is sometimes used in tanning some kinds of leather. The small trees are used for walking-sticks and for umbrella handles. The berry is crowned with a persistent calyx of a black or dark-purple color when ripe, and when the four short thick sepals are rubbed off a scar is left like an elevated ring. At the other extremity of the fruit there is a shorter stalk attached.

The berry has a brittle, woody shell or pericarp, easily cut, of a dark ferruginous-brown color externally. The roughness on the surface is caused by the small essential oil receptacles. The berry is less aromatic than the pericarp. Its hull consists of a delicate epidermis of large thin-walled cells with light or dark red contents which are called portwine cells (see illustrations). Fig. 46, Chap. III.

The fruit is two-celled, each cell containing a single flattish or kidney-shaped berry. The embryo is large and spirally curved, and the berry, when ripe, is filled with a sweetish pulp, which has then partly lost the aromatic property which it contained in the unripe state.

HARVESTING OF ALLSPICE

The aroma is supposed to be a mixture of the aromas of nutmegs, cloves, and cinnamon.

The microscope shows that the outer layer of the pericarp just beneath the epidermis contains, with its collection of brown cells, an interior mass of fibro-vascular bundles traversing a mass of tissues of constructed parenchymous-walled cells, containing resin and tannin and small crystals of calcic oxalates. The seed contains much starch in minute grains, and yields from 3 per cent. to 4¼ per cent. of volatile oil, by distillation. This oil is composed mainly of eugenol $C_{10}H_{12}$, and very closely resembles the oil of cloves in all respects, but in odor, the difference being in the nature of the sesquialteral accompanying the eugenol. Its specific gravity is 1.04 to 1.05 at 15 degrees C. The yield of oil from the leaves is nearly 1 per cent.

Polarized light is a most important aid in examining powdered allspice, as it brings out strongly the stone cells and ligneous tissue (Fig. 1, Chap. III), and differentiates these from the great mass of other matter. It also makes the oil cavities distinct.

It is hard to give a true chemical composition of pimento, but a good understanding of the tannin should be known, and especially a good estimation of the volatile oil. The amount of ash found in pimento is about 6 per cent. in the whole and 5 per cent. in the powdered state.

The chemical composition of a sample of whole pimento was found to be as follows:

Water,	6.19	Undetermined,	59.28
Ash,	4.01	Albuminoids,	4.38
Volatile Oil,	3 to 4½	Nitrogen,	.70
Fixed Oil,	6.15	Tannin Equivalent,	10.97
Crude Fiber,	14.83	Oxygen Required,	2.81

The best adulterant is baked barley.

The specific gravity of the volatile oil is 1.04 to 1.05 at 15 degrees C.

Pimento meal loses its aromatic flavor very rapidly.

*The taste of allspice is warm, aromatic, pungent, and slightly astringent, and it imparts its flavor to water

* State of Michigan, Dairy and Food Commission.

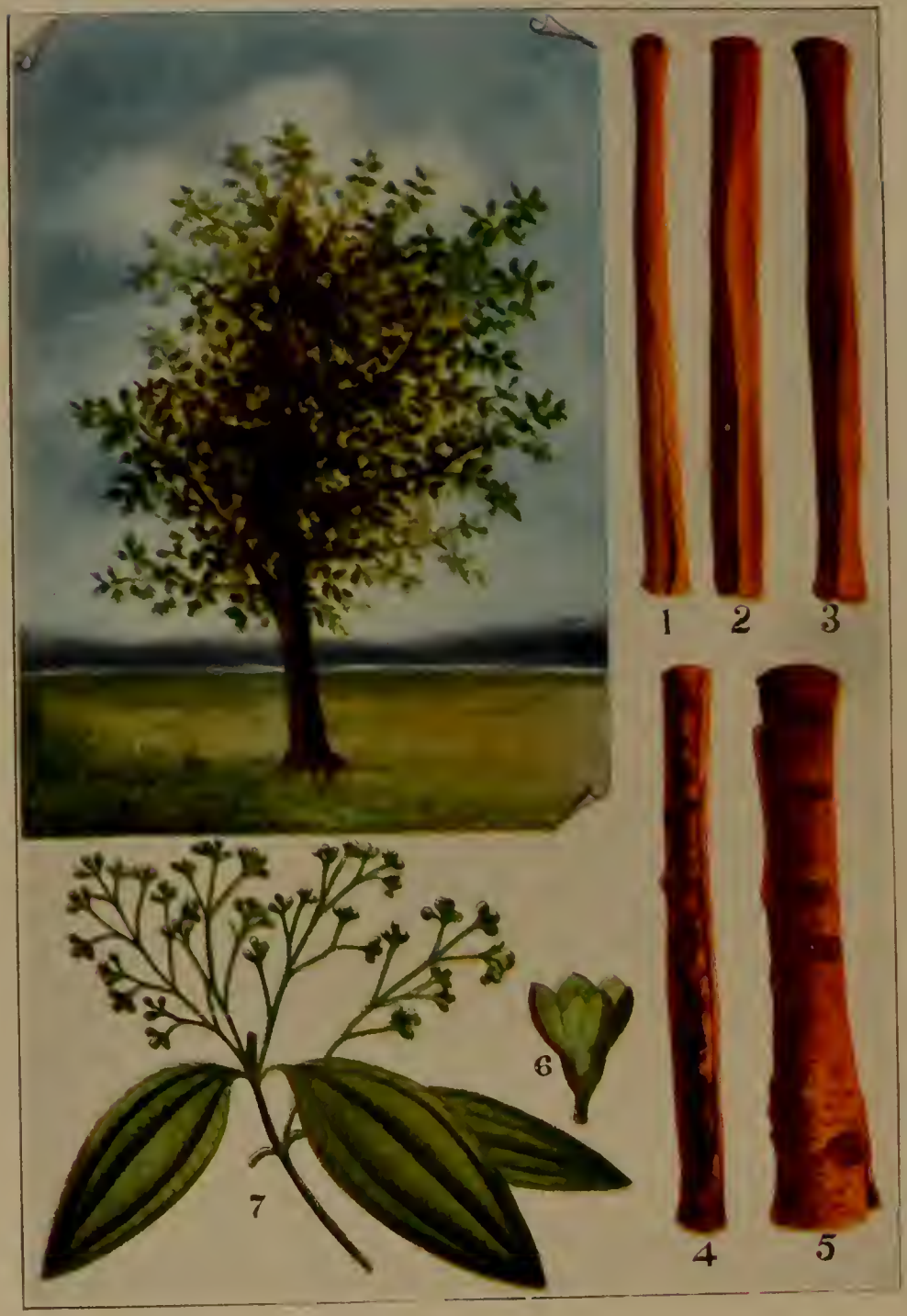
and all its virtue to alcohol. The infusion with water is of a brown color, and reddens litmus paper. Allspice yields volatile oil by distillation, a green fixed oil, a fatty substance in yellowish flakes, and tannin, gum, resin, sugar, coloring matter, malic and galic acids, saline matter, moisture and lignin.

The green oil has the burning, aromatic taste of pimento, and is supposed to be the acrid principle. Upon this, therefore, together with the volatile oil, the active properties of the berries depend. The shell contains 10 per cent. of volatile oil, and perhaps a little chlorophyl.

Allspice is reported to contain an alkaloid having the odor of caneine. The volatile oil, which is used as a flavoring in alcoholic solution, is of a brownish-red, clear appearance, and has the odor and taste of pimento, but is warmer and more pungent. It is readily soluble in alcohol, and if two drops of the oil be dissolved in one fluid drachm of alcohol, and a drop of ferric chloride test solution be added, a bright green color will be produced. If one C. C. of the oil be shaken with twenty C. C. of hot water it should not give more than a scarcely perceptible acid reaction with litmus paper.

If, after cooling, the liquid be passed through a wet filter, the clear filtrate will produce, with a drop of ferric chloride test solution, only a transient greyish green, but not a blue or violet color, a fact which indicates the absence of carbolic acid.

Pimento oil consists, like the oil of cloves, of two distinct oils, a light and heavy oil, separated by distilling the oil from caustic potassa. The light oil passes over, leaving the heavy oil behind, combined with the potassa. The heavy oil may be recovered by distilling the residue with sulphuric acid. The heavy oil has the acid property of combining with the alkalides, forming crystallized compounds, which is identical with the eugenol from the oil of cloves, from which is prepared the vanillin of commerce. Powdered allspice is often adulterated with clove stems, peas, almond shells, cracker dust, etc.



CINNAMON AND CASSIA

1 Ceylon
2 Batavia
3 Cassia Liguea
4 Java
5 Sargon
6 Cassia Liguea bud
7 Leaf stalk or flowering twig

CHAPTER IX

CINNAMON AND CASSIA

Robbed of your bark in masses large,
It's sent abroad by ship and barge;
And India's fragrance you bestow,
In summer climes and frigid snow.

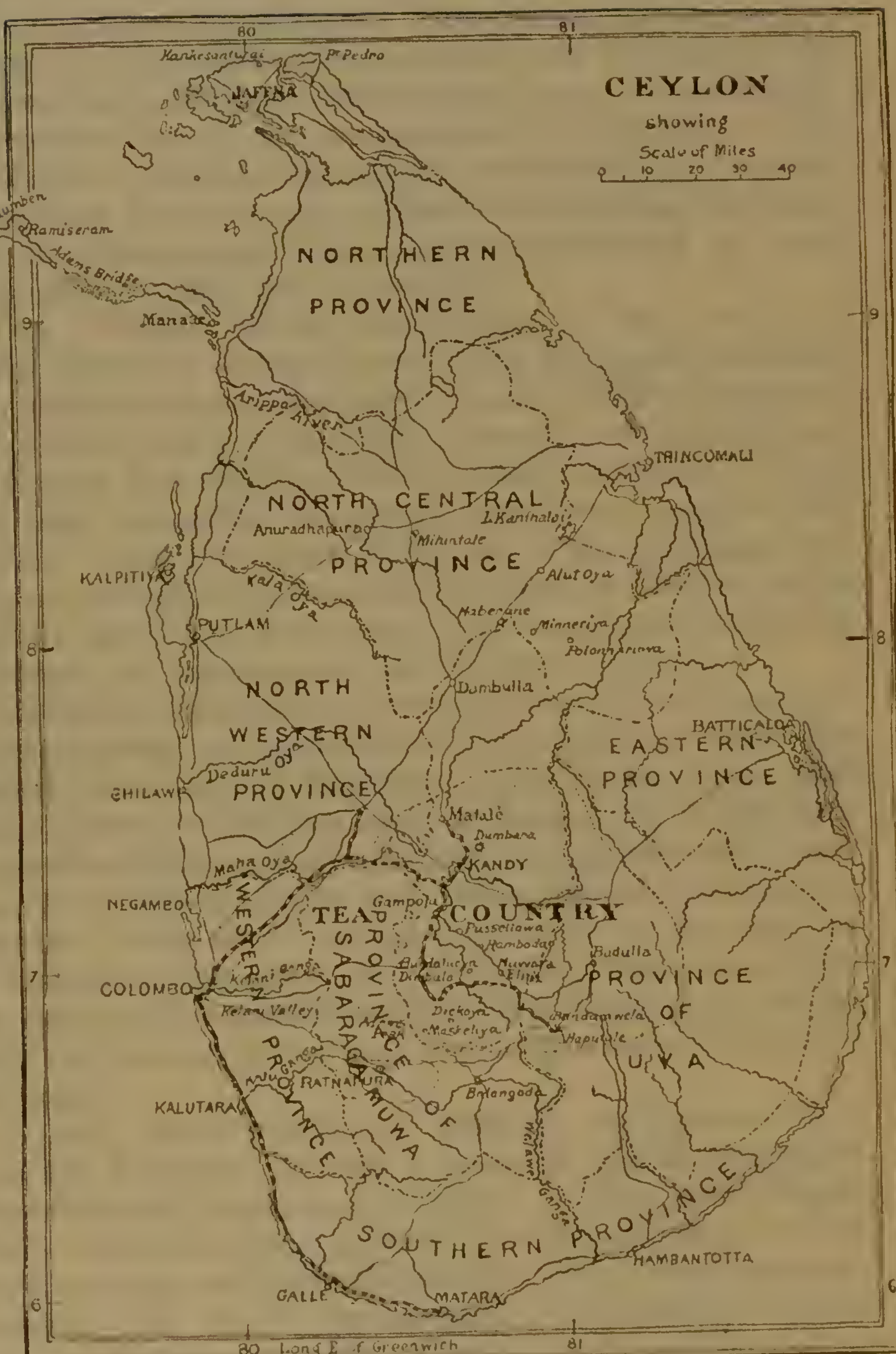
THE einnamon tree has been known to live two hundred years and its history is nearly as old as the history of man. It appears to have been the first spice sought after in all Oriental voyages, and is one of the few condiments that has been honored with a price that only the wealthy ean buy. Both cinnamon and cassia are mentioned as precious odoriferous substances in the Masonic writings. Bible history mentions einnamon at a very early date in Exodus, Chap. XXX, 23; in Proverbs, Chap. VII, 17; in Song of Solomon, Chap. IV, 14, being then introdueed by the Phœnieians. It was likewise known to the Greeks and Romans under the name of kinnamomun. Vespasian, on his return from Palestine, dedieated to the Goddess of Peace, in one of the temples of the Capitol, garlands of einnamon enclosed in polished gold, and in the temple built on Mount Palatine by the Empress Augusta in honor of Augustus Cæsar, her husband, was placed a root of the einnamon tree set in a golden eup. It is recorded that two hundred and ten burthens of spiee were consumed on the funeral pile of Sylla, and that Nero burnt at the obsequies of his wife, Poppæa, a quantity of cinnamon and eassia exceeding the whole importation of one year. Dr. Carl Schumann's Kirtisehe unter Suehungen uber die Zimtlander, published as a supplement to Petermann's Mitterlungen, is a most erudite contribution to history of geography and commerce. The author earefully examines the notiees on einnamon and eassia to be found in the writings of the aneients and of the Arabs, and critically examines these by the light of modern researeh. The ancient Egyptians procured

their cinnamon from punt, which is identified with the Rego Cinnamonifera at the promontory of Garadafiri of the modern Somaliland. But neither cinnamon nor cassia was a product of this region, nor are they at the present time, which is amply proved and illustrated by a consideration of the geographical distribution of the Louracea. Arabian merchants intentionally shrouded in mystery their manner or place of obtaining cinnamon and, in consequence, the ancients entertained the most preposterous ideas on the subject.

The "Khisit" of the inscriptions of the temple of Doral Bahari is correctly translated cinnamon or cassia. The latter word and the gizi of Galen and the Keziah of the Hebrew are derived from it, but it is of itself a corruption of Kei-shi, the Chinese name for cassia. From this fact, the author concludes that China supplied the ancient world with most, if not all, of its cinnamon, but did so through traders settled in parts of Arabia or the Somali coast, who maintained their monopoly until the discovery of cinnamon in the Island of Ceylon.

Herodotus relates that cassia grew in Arabia, but that cinnamon was brought there by birds from India, the fabled birthplace of Bacchus. This writer states that cassia grew in a shallow lake, the borders of which were infested with winged animals resembling bats; that these were powerful creatures and uttered piercing cries; but that the Arabs made war against them for the purpose of obtaining the spice and, defending their eyes from the attack of the monsters, drove them from their stronghold for a brief period and then, unmolested, collected the cassia.

A still more marvelous account was given by a Grecian historian of the manner in which cinnamon was obtained, which is as follows: "The Arabs themselves were perfectly ignorant of the situation of the favored spots which produced this spice; some, however, asserted with much appearance of probability that it grew in the country where Bacchus was born, and they gave the following account of the plan resorted to for obtaining cinnamon: Some very large birds collected together a quantity of the shoots and small branches of


CEYLON
showing
Scale of Miles
0 10 20 30 40
NORTHERN PROVINCE
NORTH CENTRAL PROVINCE
NORTH WESTERN PROVINCE
EASTERN PROVINCE
WESTERN PROVINCE
SABARAGAMUWA PROVINCE
TEA COUNTRY
PROVINCE OF UVA
SOUTHERN PROVINCE
JAFFNA
Pt Pedro
INDIA
Ramiseram
Adams Bridge
Manaar
AripPa River
TRINCOMALI
Anuradhapura
Mihintale
L. Kantalai
Alut Oya
KALPITIYA
PUTLAM
Kala Oya
Minneriya
Polonnaruwa
Dambulla
BATTICALOA
Deduru Oya
CHILAW
Matale
Dumbara
KANDY
Maha Oya
NEGAMBO
Gampola
Pussellawa
Ramboda
Badulla
Nuwara Eliya
COLOMBO
Kelani Valley
Dickoya
Maskeliya
Bandarawela
Haputale
RATNAPURA
Balangoda
KALUTARA
HAMBANTOTTA
GALLE
MATARA
80
81
9
8
7
6
Long E of Greenwich

the cinnamon and built their nests with it on the lofty mountains inaccessible to man; and the inhabitants of the country placed large pieces of carrion flesh near the haunts of the birds who bore it to their nests which, not being made strong enough to hold the additional load, gave way, falling to the valley below, where it was gathered up by the natives and exported to foreign lands."

It was exported into India in the time of the authors of the Periplus of the Erythræan Sea, and even long before it was much used among masters of the ancient world.

Celsius recommends that it should be given "perparationem." It is mentioned in the herb book of the Chinese Emperor Shen-nong, and was known in China 2,700 B. C. under the name of "Kwei" and was introduced into Egypt about 1,600 or 1,500 B. C., and China maintained her monopoly until the discovery of cinnamon on the Island of Ceylon. It would appear that cinnamon was not confined to Asia, much less to Ceylon, in former times. Ibn-Batuta is credited with having first mentioned the Island of Ceylon as a cinnamon region, for the Sayalan of Kazwini and Yakut is not Ceylon, as supposed by Colonel Yale and others, but Rami or Sumatra.

The Romans were supplied by the Arabs, the cinnamon being carried up the Nile in ships, then across the desert on camels to the Red Sea, which they crossed to a port of Arabia, where India merchants were met and exchanges took place, the cinnamon being the most important article of commerce from India, and in this way the odors of the far-famed cinnamon spice came, by poetical liberty, to be associated with "Araby the Blest" by the system of transit by caravans overland through Arabia.

The Romans communicated with India only once each year during the reign of Augustus, and at such times invested about £403,000 in the trade of cinnamon. They figured on about 100 per cent. profit. History tells us it was at one time sold in Rome at $25 per pound.

Even in comparatively modern times the products of the more eastern parts of Asia were chiefly imported

into Europe by way of Egypt. The Venetians almost entirely controlled this lucrative branch of commerce, and through their hands these articles were supplied to the rest of Europe. But when the passage around the Cape of Good Hope was discovered by the Portuguese, in 1498, Indian commerce was turned into a different channel and the Portuguese soon supplanted the Venetians in the traffic of Indian commodities. Early in the sixteenth century they obtained permission from the powers of Ceylon to establish a factory on that island. Although the Europeans had obtained license from the ruling authorities to pursue this trade, the Arab merchants did not submit without a struggle to the intrusion. They vigorously opposed the landing of the strangers who were taking their trade away from them, but the Portuguese built the fort of Colombo and soon after made a treaty with the king of Kandy, by the terms of which the Portuguese agreed to assist the king of Kandy and his successors in all their wars and in return were to receive out of the Kandyan territory an annual supply of 124,000 pounds of cinnamon. The Dutch viewed with a jealous eye the rich and thriving Portuguese, and soon after they established themselves in the East Indies, and became desirous of monopolizing the cinnamon trade, they tried to undermine the Portuguese by showing favors to the king of Kandy, and in this way tried to have him drive the Portuguese from the island. The Dutch were partly successful in their bold attempt, as the king of Kandy, in 1612, agreed to sell the Dutch East India Company all the cinnamon that he could collect in his kingdom. The Portuguese, however, would not quietly submit, but after a long contesting of the matter it ended in 1645 in a treaty of peace with the Dutch, by which both nations were to share equally. During the time this treaty was in force both nations employed native cinnamon cutters to cut and prepare the aromatic bark, and all that was collected on either side was deposited in a central situation upon the river Dondegam, near Negombo. When the cinnamon harvest was completed an equal division of the quantity obtained was made, each party paying half the

cost of harvesting. This amicable arrangement was not, however, of very long continuance, and in 1652 a fresh war proved more disastrous to the Portuguese, who were finally expelled from the Island of Ceylon in 1658. The Dutch now made strenuous efforts to obtain a monopoly of the cinnamon trade, and they also tried for the exclusive commerce of the Malabar coast. This was very expensive to the Dutch, as merchants of other countries, by paying a good price, were always able to obtain it from the natives notwithstanding the decrees of the princes of the country.

All through the Portuguese and Dutch periods, cinnamon was the principal source of wealth. The Dutch first tried cultivating it in 1767, thereby occasioning much fear on the part of the native Sinhalese that the cultivation would ruin the cinnamon forest. Previous to this time, in 1506, large trees were found by the Portuguese growing wild and scattered through the interior of Ceylon. The Dutch, after many attempts to restrict the cultivation of it to the Island of Ceylon, passed a law making the removal of the seed from the island a crime punishable by death. The law also provided that persons should be compelled to care for the tree, even if it were on their property, and it further provided that any person discovered in cutting a shrub of cinnamon on the island should have his right hand cut off. This law so retarded planting that up to 1808 or 1809 only 15,000 acres were cultivated. Exportation was restricted to 8,000 bales of 100 pounds each. In 1796, Ceylon was captured by the English. They put an end to these barbarous laws, but a monopoly was continued until 1832. Afterwards the cultivation of the tree was introduced by the Dutch into their own islands and the Malay Peninsula, an act which would have been much more creditable to the Dutch had they tried this means earlier, instead of warring with other countries.

It is estimated that the world's production of true cinnamon does not exceed 400,000,000 pounds, while an equal amount of cassia is collected chiefly in China and the East Indies. Cinnamon is not an article which enters into the daily food of the masses of the people,

and the consumption does not increase with a low price or decrease when the price is high. The present consumption does not equal one pound to each 500 inhabitants of the earth.

Cinnamon and cassia blume are the barks of several species of genus cinnamomum (natural order lauroceœ) and the true cinnamon, with which cassia is often compounded, is produced by cinnamomum Zeylanicum, formerly called Laurus, which is a member of the laurel family (French, *Cannele de Ceylon;* German, *Zimmt Ceylon, Zimmt Kaneel;* Arabic name, *Kinsman*).

The true cinnamon tree, if left in its natural states, varies in height and dimensions in different sections, growing to the height of twenty to forty feet with a straight trunk, and is from twelve to eighteen inches in diameter. It is the hardiest of any of the spice trees, and in its natural climate grows on almost any soil and at almost any elevation, with an average temperature of 85 degrees and an inch of rainfall for every degree. It may be grown by cultivation in any place where it is found growing wild. When sheltered from the wind and the direct rays of the hot sun, it will grow from 1,500 to 8,000 feet above the sea level. It is found in those angles of the mountains which face the monsoons. Where it is cultivated, it is cut back when six years old to about fifteen feet and every two years thereafter, and then has the general appearance of an orange tree. It is an evergreen with a beautiful scarlet foliage which changes to a dark glossy green.

The leaf and leaf-stalk are globous and are nearly opposite, oblong, ovate, obtuse, the largest being from eleven to twelve centimeters in length and from five to seven centimeters in width. The leaf is coriaceous and shining bright green above and glaucous beneath. Besides the middle vein there are also two other veins on each side starting from the stalk, rounded to the shape of the edge of the leaf nearly to its extremity. The leaves on drying acquire a reddish brown color due to the oxidation of the essential oil which they contain.

Small, dingy, white or greenish blossoms disposed in

terminal panicles appear in January or February, their strong and unpleasant odor resembling a mixture of lilae and rose. In color they resemble mignonette. By May they develop into small, purplish, brown-colored berries enclosed at the base by a calyx and shaped like an acorn. The berry contains a soft brown pulp and has but one seed, which ripens in August and is gathered by the natives for the fragrant oil it contains.

The entire tree contains an aromatic flavor of cinnamon and no part of it is lost, as the entire tree is used for some purpose, every part of it having a distinct flavor. It is impossible to discover the cause or causes by means of which different qualities are produced from the same branch, since the shoots and the same tree are found to yield cinnamon of different qualities. The quality of a cinnamon tree is often determined by the size of the leaves, as well as by tasting the inner bark; the larger the leaf the better bark the tree will afford. The quality of the bark varies very much with local conditions, some being so inferior as to be harvested only for the purpose of adulterations. Two of these inferior varieties are the korahedi and the velli, the latter growing more quickly than any other cinnamon known, being often at two years' growth four to five inches in girth and eight to ten feet high. It has a very coarse bark and takes its name from sand velli because it grits under the teeth. The bark is often so hard that it will turn the edge of a peeling knife. There are several varieties of cinnamon. Next in order after Ceylon are the following:

1. *Penne or Rosse Kuroondu* (which signifies honey or sweet cinnamon).
2. *Naya Kuroondu* (or snake cinnamon).
3. *Kapooru Kuroondu* (or camphor).
4. *Kabatte Kuroondu* (or astringent cinnamon).
5. *Sevel Kuroondu* (or mucilaginous cinnamon).
6. *Dowool Kuroondu* (flat or drum cinnamon).
7. *Nika Kuroondu* (or wild cinnamon, whose leaf resembles that of nieaso or vitx negundo).
8. *Mal Kuroondu* (or bloom or flower cinnamon).
9. *Tompat K.* (or trefoil cinnamon).

Only the first four are strictly varieties of the Laurus Cinnamomum, and as the names given are only known by the planters of cinnamon or by the native Sinhalese, I will not refer to them again except by the names known to commeree.

The true cinnamon is a native of the Island of Ceylon and it adds sweetness to the breezes which "blow softly o'er Ceylon's Isle," and nowhere else has it been found growing so well or so spontaneously. The large trees scattered through the older forests of the interior are every year gorgeous in bloom of every shade of pink from a faint rose to blood red. The Ceylon variety is the best in the world, and the product in 1904 was 9,216 hundreds, valued at $278,430. It grows up six or seven feet, like willows, and the twigs are cut down for exportation; the smaller the twigs the finer the quality.

The farm plantation is called a "Cinnamon Garden." In Ceylon these gardens are the most famous in the world, the owners living like princes. Some of the carved wood in these homes are literally worth their weight in gold. There are certain trees and species that are taken in charge by the royal surgeons. Such have the official stamp indicating what their medical value is. This cinnamon commonly sells at $15 to $25 per pound and sometimes as high as $100. While the ordinary China cassia, handled by our groecrs, sells at wholesale at six or seven cents a pound. The medicinal cassia, however, has about the value for cooking purposes that the ordinary Saigon cassia has. Many cinnamon gardens are being rooted up and planted to tea, however, as tea culture is more profitable. A sandy loam soil mixed with humus matter is favorable for the culture of cinnamon, and old, worn, coffee estates are often used in Ceylon for cinnamon plantations.

The cinnamon crop has few enemies. Cattle, goats, and squirrels eat the growing shoots while tender. The principal insect enemy is a minute beetle that breeds in the leaves and sometimes does injury by retarding the growth and rendering the wood unpeelable, as well as unhealthy. A red worm, about two inches long, eats its way up the center of some old and unhealthy sticks

COLOMBO, CEYLON

A PLANTATION IN CEYLON

growing on partially deeayed roots, but the injury from the insect is searcely worth considering. White ants eat dead roots but seldom injure living wood, and they are to some extent enemies of all other insects whieh prey upon einnamon trees. They build their nests around live branches, but this does not interfere with their growth. Crows and wood pigeons devour the berries with great eagerness, but in the process of digestion the produetive qualities of the seed are not injured and by this means the seed is scattered over a large extent of eountry. Plants may be raised from the seed or by "laying." The culture of the best kind, whieh is the true C. Zeylanicum, a eultivated Curanda or honey einnamon (ealled penne rasse Kuroondu by the Sinhalese) is from the Kadirona, Ekla and Muradana gardens, between Colombo and Negunbo, which oeeupy a traet of country upwards of ten miles in length and in a winding eireuit; as well as from the Maratuwa and Beruwala gardens, and those of Galle and Matara.

There is also a Cingalese bark found in the arehipelago, whieh is very pungent and mueh resembles the true bark from Ceylon. It brings a fair priee on the market, and is more aromatie than that of Ceylon. There are several kinds of it, some of it bringing an exorbitant priee, and it is eultivated solely for royal use. The outer bark is never removed from it and for that reason it has the dark Java eolor. It, like the Saigon, is exported in 500-pound bundles.

No system was first regarded in planting einnamon groves in Ceylon. This negleet greatly hindered eultivation. The usual way of establishing a garden is first to eut down all the brush and small trees on new ground, leaving the tall trees at intervals of from fifty to sixty feet, as a protection from the wind and from the strong hot rays of the sun. The fallen brush is next burned and the plat cleared is lined out. The soil is turned up for hills in squares of about one to four feet at intervals of from six to ten feet, aceording to the riehness of the soil. The longer intervals being provided with the rieher soil. The ash from the burned brush mixed with the broken ground and vegetable matter, and from four to

five of the berries are sown in each hill. Branches of trees are placed over the earth where the seed is planted to protect them from the sun and to keep the earth from parching.

Care should be taken in selecting the seed, as that from trees ten years old and up is best. Seed from old trees with coarse wood produces coarse and unpeelable bark, which helps to increase the chips. If the tree is to be raised from shoots, the youngest, or those not containing more than three leaves, must be selected, for if older they will surely die. The method of raising plants from layers is very good, because the numerous side branches which issue from the bottom of the trunk also furnish an abundant supply, well adapted for the purpose intended. The transplanting of the divisions of old roots or stumps is also much approved, as they yield shoots of useful size twelve months after planting. Great care must be taken in planting or removing the roots or the divisions of the parent stump, for should any of the rootlets become bruised, even to the tenth part of an inch in diameter, the injured part will certainly perish. Care must also be taken when removing the roots or stumps to keep as much earth on them as possible, or as can be carried with them. The dirt originally taken from the holes should not be returned, but there should be used, instead, that from the surface which has been burned and contains ashes mixed with vegetable manure. When old cinnamon trees are cut down and burned on their stumps, the roots will later produce a superior quality of cinnamon. Planting of seed is least advantageous as it requires greater attention than other modes, and the trees are longer reaching perfection. As they are planted four to five seeds in a hill, and as they are quite sure to germinate, the plants grow in clusters. Should no rain fall after planting on either the roots or stumps, they must be kept watered every morning and evening until the sprouts shoot out fresh buds. This will be in about two weeks from the planting and is an indication that they have taken root. In a month the shoots will be from three to four inches high. When seed is sown and dry weather

GALLE HARBOR

NEGOMBO CANAL

follows, the seedlings will perish. It will be necessary, therefore, to plant the ground anew. It is wise, therefore, to raise plants in a nursery to supply the vacancies in the hills.

For a nursery, a plat of rich soil is selected, free from stone and cleared from brushwood, except the tall trees. which are left for shade. The ground is dug over and formed into beds from three to four feet wide and the seed is sown nine to twelve inches apart and shaded at eight to twelve inches above ground, by a pendall of leaves. The plants are kept watered on alternate days until they have one pair of leaves, but the shade should not be removed until the plants are six to eight inches high and are able to bear the sun. The seed will germinate in from two to three weeks. The planting takes place in autumn when the seed is gathered fully ripe. The seeds are heaped up in shady places, as the sun would crack and spoil them; the outer red coating will rot, turn black, and come off easily; the seed is then washed and dried in the air, but not in the sun; that which will float on water is rejected. The plants are taken from the nursery in October and November, and under favorable situations they will grow from five to six feet high in from six to seven years. A healthy bush will then afford two or three shoots ready for peeling, but should unfavorable results occur they will not yield for from eight to twelve years. After the plants are fully established in the field, very little cultivation is required, except to keep them free from the weeds. In a good soil from four to seven shoots may be cut every two years. Sometimes thriving plants may be cut first in four years and sometimes even in two years.

The quality of the bark depends upon its position on the branch; that from the middle is the best, that from the top second, and that from the base, which is the thicker part of the branch, the third grade. Shoots exposed during growth to the direct rays of the sun have their bark more acrid and spicy than the bark of those which grow in the shade. A marshy soil rarely produces good cinnamon, its texture being cross-grained and spongy, with little aroma. The quality is deter-

mined by the thinness of the bark — the thinner and more pliable the finer. The finest quality of bark is smooth and somewhat shiny and of a light yellow color. The shoot bends before it breaks, and when the fracture occurs it is generally in the form of a splinter which has an agreeable, warm, aromatic taste with a slight degree of sweetness.

Two crops are gathered each year — the first from April to August and the second from November to January. These particular seasons are selected for harvesting on account of their coming just after the heavy rains, just as the young, red leaf assumes the normal dark green. The sap then is more active and the bark is more easily detached. If there is not sufficient rain the garden may have to be cut over several times.

In harvesting, the shoots are not all cut at one time, but by degrees as they arrive at the required maturity. Those sticks which promise to peel at the next cutting are left. In pruning, with plenty of help, every stick older than two years is cut, whether it will peel or not.

A grayish, corky appearance is an indication of the fitness of the shoots for cutting. A certain amount is marked off for each day's cutting, and it is an offense to go outside of that limit, but within the limit every one is allowed to go where he pleases. When fifteen or twenty persons are allowed to scramble as they please, the trees are agitated as by a whirlwind passing over them and in less than forty minutes the best sticks are cut and appropriated. Then systematic work begins. Every stick is then tested before cutting, and, if the wood is in a fair condition for peeling, it will take about two hours to finish a plat of 484 square feet. There are four such plats to an acre. They yield from twenty-eight to forty-eight pounds each. When called off, no one is allowed to cut another stick. (See illustration.)

As long as the seed is on the bushes, which is nearly till the end of the year, the sticks carrying them do not peel, owing possibly to the growth being checked and with it the free flow of sap in the effort to mature the seed. If, therefore, this seed is allowed to remain

CUTTING CINNAMON

great loss results, as by the time the seed-bearing bushes are peelable they will have grown so much as to yield coarse bark, fit only to quill coarse cinnamon, or not fit to be quilled at all. To avoid this loss the seed is stripped from the limb, when it will peel in its proper time. A plantation should not be expected to bring large returns for eight or nine years.

After the crop, which is taken from four to six inches above ground, has been cut, the stumps should be covered with fresh earth gathered from the space between the rows and formed into a heap around the base. Sometimes a fire is made on the old stump. The next year two or three times as large a crop may be gathered, and so on year after year, until at length the bushes will become so thick as to admit only the weeders and peelers. The only manure required is the weeds, which three or four times a year are placed between the rows and covered with earth. When the shoots are harvested from old stumps, they should be cut with one stroke of the heavy knife, in order to avoid splitting the stems. As the cutting takes place twice each year, there is a succession of young wood of different ages on the tree.

The branches are cut off from three to five feet long when tipped at the ends by means of a long knife in shape of a hook or sickle (catty). The shoots, after they have been cut and the tops have been removed, are tied into bundles and carried to the "wadi or peeling shed," where they are allowed to sweat for the preparation of the bark. The leaves, side branches, and outer bark are next removed from the shoots. The peeler (Chaliyas, Sinhalese caste of cinnamon peelers), sits on the ground beside his bundle and with his left hand cuts the inner bark in two pieces (and sometimes three if very heavy and thick), longitudinal slits the entire length of the stick. It is then easily removed by means of a peeling knife (mama), which is round-pointed and has a projecting point on one side for ripping and running beneath the bark and lifting it about one-half inch on both sides. The bark will usually come off in halves eight to nine inches wide. The assortment

is made at the same time. The coarse peelable bark is for coarse cinnamon, and that which is not peelable goes as chips. If the bark adheres firmly, the separation is facilitated by friction with the handle of the knife rubbed dextrously down it or with some smooth, hard piece of wood of convenient length.

When the day's work is finished the assorted bark is piled in a small enclosure made by sticks driven in the ground and is covered with the day's scrapings and with a mat. This treatment is called "fermenting," but it is rather to hold the moisture and soften the bark for the next operation. After remaining twenty-four hours, or on the morning of the second day, three sticks are driven into the ground at such an angle that they will cross each other about one foot high. They are tied firmly at the point of crossing and are used for supporting the end of a fourth stick, the other end of which rests upon the ground. Before this support the native sits upon the ground and taking a strip of the bark places it on the stick and holds the upper end firm with his foot. Then with a small curved knife, having a slightly serrated edge, he scrapes off the cuticle, for if any remains it will create a bitterness. (See illustration.) While it is yet moist with sap, it is placed with concave side downward to dry and it then contracts and curls into tubes or quills. The pipe maker, as he is called, is furnished with a board about one yard in length, a measuring stick, and a pair of scissors. He takes a bundle of the prepared sticks and sorts them into three or four grades, according to quality. Slips for the outer covering are then selected, the ends being cut square with the scissors. Placing this on the boards, he proceeds to pack within it as many of the smaller pieces (see illustration) as it will close over when dry, which is called piping. When the day's work is finished the pipes are arranged on parallel lines stretched across the shed. They are then placed on hurdles covered with mats to dry in the sunshine until firm enough for handling. Afterwards, if necessary, the outer edges are pressed in and the ends are dressed and they are tied into bundles of about thirty pounds each. Three bun-

CUTTING AND QUILLING CINNAMON

PEELING AND QUILLING CINNAMON

dles are tied together to form a bale. This bale is covered with canvas. In this form the product is put on the market ready for export, where it appears in long brittle sticks of a pale yellow-brown color or white to lightish yellow (Fig. 1). The best grade is nearly as thin as paper, not being more than one-eighth to one-sixteenth of an inch in thickness. It has a very delicate flavor and is very superior in aroma and strength to the ordinary Chinese variety. It lacks the strength of Saigon, however, and is seldom called for except for medicinal use, for which in many cases it is highly valuable. A well-made cinnamon pipe, as it is called, will be of uniform thickness and quality; the edges will be neatly joined and in a straight line from end to end with the appearance of a tight roll of paper, which will feel firm under pressure of the thumb and finger, and the size of the pipes will vary according to the quality of the spice. In the finer sorts there are from fifteen to twenty-four pipes to the pound. In the next grade there are from ten to twelve. The coarser are stuck together without regard to appearance. In Ceylon the yield is about 150 pounds per acre, but on good soil and with careful tillage and manuring larger returns are obtained.

Following the Ceylon in value are the Saigon, Java, and Batavia and China. The Saigon (Fig. 5) comes from Cochin China, taking its name from the city of Saigon. (See illustration.) The thinner-quilled Saigon bark, which is from selected twigs and smaller branches, is known as Java (Fig. 4). It has a very dark color and possesses an aroma and strength superior to these qualities in the Saigon.

The Java is sold chiefly in the whole state (the outer rind is never removed) and in a variety of packages known as piculs, containing 135 pounds each, mostly in cases, sometimes valued higher than Ceylon. The Tellicherry and Malabar are from Bombay and the province of Malabar. The Tellicherry is equal to the Ceylon in appearance, but the interior surface is more fibrous and the flavor is inferior and the bark thicker. It is superior to the Malabar, which is the true cinnamon

introduced into India by the English. The Malabar contains nearly all the qualities of the Ceylon, but is paler in color with a feeble and less permanent odor. The sticks after piping are in length equal to those of the Ceylon, but the bark is shorter and the length of the stick is due to the method of telescoping the sticks of bark into one another. Batavia bark (Fig. 2) has a pale straw color and is a heavy bark superior to China Cassia Lignea (Fig. 3). It is exported in rolls of about fifty pounds each.

The bark of the larger or coarser shoots cannot be quilled and is removed in thick pieces. When mixed with the bark of the prunings and with those sticks which do not peel well it is known as chips. It brings a low price on the market and is used for grinding; and, although it does not have the delicate flavor of the quilled, what is lacking in delicacy is made up in pungency and, therefore, in many cases, it is preferred. Chips bring so low a price in the market that they may be purchased by the miller of spices and sold in the pure powdered state at a price much below what he can sell the bark at. This fact may account in a measure for prices given in the table in chapter II, page 7, on adulteration.

The exporting of cinnamon chips is carried on by the planters to a great extent and at a great detriment to themselves. By doing this there is shortsightedness on their part, as the chips are bought by the miller at a low price in place of the high-priced bark, which necessarily must partly go begging for a market. Thus, the more valuable product so depreciates as to leave but little profit for the grower; his margin of profit is so small that he does not give his cinnamon grove proper attention and many times cuts it for wood. If the planter would distill his waste pruning and coarse chips for the oil which they contain he would be well paid for his labor.

The cultivators of cinnamon give employment to a large number of people, several thousand being now engaged in the cultivation of the trees and the preparation of the bark. The pruning immediately follows the cutting and consists in cutting out all wood of more than

BATAVIA

SAIGON

two years' growth and reducing all stumps left too high and removing all weak and crooked shoots and superfluous branches. This waste material, with the weeding, is buried near the outer roots, as it is found that organic matter is an excellent fertilizer for cinnamon, as the shoots reach out in all directions and permeate the decaying matter and so bring much benefit to the tree. It will not do to raise a mound around the base of the trunk, as the roots are thereby forced against their natural course and throw themselves into the mound. When this is once done they must be allowed to remain, as any disturbance would injure the tree. When the Ceylon cinnamon tree becomes too old to produce good growth it is cut down and the bark removed from the larger branches and the trunk, and is called mate cinnamon.

Although the finest bark is obtained from the cultivated trees there is much bark obtained from the uncultivated, of which C. multiflorum and C. ovalufolium are used for purposes of adulteration.

Cassia bark (Fig. 3), French cassia and German cassia, are the dried bark of a tree which grows twenty to forty feet high, sometimes even sixty feet high, irregular and knotty, with large spreading horizontal branches, outer bark thick, rough and scabrous, with ash color, speckled inner bark reddish with dark green and light orange color. It is known to commerce as cassia lignea or China cinnamon, and is from the Cinnamomum aromaticum. It is found in South China and is a native of Ceylon, Cochin China, East India, and Java, and has been brought from China since the earliest days of history. It is produced by an undescribed tree of several species of cinnamomum, differing from each other in foliage and in inflorescence and aromatic properties, and has about as many names in Chinese as there are provinces in which it is found growing. It is found most abundantly in the province of Kwangsi in the south of China, large quantities being brought to Canton annually from "Kwei lin Foo" (literally the City of the Forest of Cassia Trees), deriving its name from the forests of cassia around it, and is the capital and

principal city of the province. The exact botanical source of China Cassia lignea was not known until 1884, although it was generally attributed to the tree now proved to yield it (Cinnamomum cassia). It is cultivated in the three following districts of China: Taiwu, Kwangsi province, and Lukpo and Loting, both in Kwang-tung province. Taiwu is about 180 miles west of Canton and from four to five miles from the West River, but the nearest cassia plantations are from twenty-five to thirty miles farther, in a southern or southwestern direction. The Loting district commences from eight to ten miles from Loting City. After leaving the West River about eighty miles of the Loting River and the Nam-Kong must be traversed before reaching the city, and from there the distance is made overland. In these plantations there are 52,600 acres which have been under cultivation for about forty years. Lukpo is least important. The city of Lukpo is situated on the northern bank of the West River. The nearest plantation is about fifteen miles distant from Lukpo City.

Cassia is also found in the following provinces: Hunan, Shensi, Hupeh, and Eonsu, and under the following Chinese names: Yuk-quai-she, Toro-Tsao, Chu-eh or Tsao, Chu-eh, Eh-Ming or Chueh Mings; for drugs — fungus, Huei-hua, Mu-erh. The Chinese have varieties which they cultivate under special circumstances, almost sacred, and by their long familiarity with different kinds and their expertness in determining its value they use it in many ways of which we are ignorant. The thick bark of the old uncultivated trees found growing near the Annam frontier is very highly valued by the Chinese on account of its supposed medicinal purposes, especially a dark bark called Ching Fa Kwei from the trees growing on the Ching Fa Mountains in Annam. The bark is stripped from the limbs as are the other grades of cinnamon. It is only about sixteen inches in length, has a dark-brown color and dull flavor, is not so sweet as true cinnamon and has a bitter taste. The bark is thick and heavy and not uniform in size. It is not enclosed or quilled and is brittle, with

a less fibrous texture. It is less pungent and has a more mucilaginous or gelatinous quality. The outer, corky bark is of a deeper color and is the kind mixed with much coarser bark, known as "Cassia Vera," which is ground by our spice grinders in place of the true cinnamon. This bark is imported in mats of from three to four pounds each, bound up in bamboo splints, and is shipped in bales of about eighty pounds.

Inferior cinnamon trees are found scattered over a large tract of country in the Indian Archipelago, C. Tamala Nees, and Ebern, extending into Silhet, Sikkin, Nepaul, Kumaon, and even into Australia. There are two species of Archipelago C., Cassia Blume and C. Burmanii Blume, the last being a Chinese variety found growing in Sumatra and Java, and the Philippines furnish "Cassia Vera." Several other cassia Cingalese species of cinnamon cassia bark are found in their respective localities.

In the Khasia Mountains of East Bengal there is the bark of Abtusifolium Nees, and C. Pauciflorum Nees, and C. Tamala Nees, and Eberm found growing at 1,000 to 4,000 feet elevations, shipped from Calcutta.

Cinnamomum iners reinw is a kind found in India, Ceylon, Java, and Sumatra, and other islands in a variable state and has a paler and thinner and different veined leaf than the true cinnamon. Young branches of the tree are collected and tied up in fagots constituting cassia twigs, which form a large article of commerce.

In order to powder cinnamon bark, it must first be passed through a cracker machine, as it is called, to reduce it to a proper size for feeding in a mill. The mill consists of a roller provided with very coarse teeth, which revolve through similar stationary teeth. The material is retained by a semi-circular, perforated plate, until it is reduced to the size of the perforation, or about the size of a coffee bean, when it is then ready for the burr stones.

True ground cinnamon (see Figs. 22 and 23, Chap. III) consists of long cells of woody fiber which represent the thin layers found in the bark and scattered

through it, consisting of a little starch in stellate cells. There is nothing more distinct between cinnamon and cassia than the amount of volatile oil the bark contains, and yet some of the inferior cinnamon bark does not contain as much volatile oil as does good cassia, but cinnamon oil is of a much higher and more delicate aroma. It is hard to detect cassia (see Fig. 41, Chap. III; adulterated, Fig. 46) in ground cinnamon, as the flavor is so similar, but the cassia contains but little wood fiber and few stellate cells and the presence of starch is more marked. To test cinnamon, experts are required. The usual test is by chewing, but this method soon makes the mouth sore. The most inferior ground cassia, however, bears such a close resemblance to the best cassia and to the true cinnamon that it may be substituted for it or used as an adulterant without being easily detected. The following instructions are useful in examining powdered cinnamon.

Make a decoction of pure ground cinnamon, also a decoction of the suspected mixture, and filter both; when cold add to thirty grams of each one or two drops of iodine, when the decoction of pure cinnamon will be but slightly affected while the mixture will assume a blackish-blue coloration. Although much depends upon the age of the oils, the greater the age of the oil the smaller the quantity of iodine solution absorbed by it. The cheap sort of cassia, or "Cassia Vera," can be distinguished from China cassia and from true cinnamon by its richness in mucilage, which can be extracted by cold water as a thick glary liquid, which on the addition of corrosive sublimate or neutral acetate of lead yields a dense viscous precipitate. The most reliable test for cassia in true cinnamon is to obtain the proportion of ash in each, the ash in cinnamon being 4.59 and 4.78 per cent., cassia lignea giving but 1.84 and "Cassia Vera" nearly the same as cinnamon, 4.08. Another test is to ascertain the amount of ash soluble in water. The quantities are 25.04, 28.98 per cent. in whole cinnamon, about 18 per cent. in chips, and 8.15 in "Cassia Vera," and 26.40 in cassia lignea. Again the proportion of oxide of manganese is never more

than 1 per cent. (0.13-0.97) in cinnamon, but it is over (1.13 - 1.53) in "Cassia Vera" and 3.65 - 5.11 in cassia lignea. The cinnamon ash will always be found white or nearly so, while both the cassia ashes are gray or brown and yield an abundance of chlorine on heating with hydrochloric acid. The cinnamon or cassia in the bark is easily distinguished, as the inferior kinds are thicker and appearance coarser and their color darker brown and duller and have a more pungent taste, which is less sweet than the true cinnamon, succeeded by a bitter taste.

The Ceylon bark is characterized by being cut obliquely at the bottom of the quill while other kinds are cut transversely. Ground cinnamon will deteriorate very rapidly. Cinnamon is so singularly sensitive in the bark that great care has to be taken in regard to its surroundings in shipping aboard vessels to prevent loss. Recourse has been made to various expedients, but it is found that the only effective safeguard is to pack bags of pepper between the bales. Ceylon alone exports 6,000 pounds of bark to this country annually in gunny bags of about 100 pounds each. Colombo (see illustration), which has one of the largest botanical gardens and the largest cinnamon grove in the world, is the principal city of export.

Cassia Buds (flores cassiæ immature clavelli cinnamomi) are the calyces of the immature flowers of the cassia tree which yields cassia lignea. The cassia buds of commerce bear a resemblance to cloves but are smaller and have the odor and flavor of cassia lignea or cinnamon. They are gathered in an unripe state at about one-fourth their normal size and are exported from Canton in piculs of 150 pounds each. Canton exported about 100,000 pounds in the first quarter of 1905, and Canton exports 19,000 piculs of cassia cinnamon of 133 pounds each and 500 piculs of twigs annually, and it is the principal city of export in the world for cassia barks. In Southern India the cassia buds are gathered from a variety of wild Cinnamomum iners reinw in a mature state, but they are inferior to the Chinese cassia buds. They have the appearance of

nails with roundish heads of various sizes, and if completely dried the receptacle is nearly dark, firmly embracing the embryo seed, which protrudes.

Seeds which are used for seeding are obtained from trees ten years old and upward, which are not cut back but are allowed to grow naturally from fifty to sixty feet apart, while the balance of the orchard is cut down every six years for the bark. The seed trees are cut only in cases of necessity to supply a great demand for the thick bark on the trunks, when some can be sacrificed.

The Chinese frequently adulterate the oil of cassia with colophony, which may be easily detected, as it has a greater specific gravity. Extra pale colophony has a specific gravity of 1.070 and the pale colophony has a specific gravity of 1.110. Any oil heavier than 1.070 should be handled with suspicion. The darker the sample and the higher the specific gravity, the greater the adulteration. The tips of the branches and the other trimming which collects are carefully dried and distilled and sold as cinnamon oil.

Oil of cinnamon or cassia depends entirely upon the amount of cinnamyl aldehyde it contains. Oil of the true cinnamon bark (cinnamomum Zeylonicum) is the finest essential oil to be had. It is worth $5 per pound, while common cassia is worth only about seventy cents. True cinnamon oil is obtained in Ceylon and is of a golden color when fresh, with an aromatic odor, and is very pungent, being powerful enough to blister the tongue, but varies by age from cherry to yellow-red, the paler varieties being the most esteemed. Cinnamon leaf is redistilled in London to obtain the desired color, although at a loss of about 10 per cent. (formula $C_{10}H_{14}$), with a small quantity of benzoic acid. Fine cinnamon oil has a taste of intense sweetness, far sweeter than sugar, and a clove-like taste is at first developed. It is largely used in perfumery and medicine. Ceylon ships about 15,000 to 40,000 ounces annually. China exports as much. After a time it loses its sweetness and is no better than cassia oil. The tree yields essential oils from the leaves, bark, and root, each

oil differing in composition and value, which accounts for the many different grades or prices for cinnamon oil found on the market. Cinnamon and cassia oils are of the same chemical compositions, their value being estimated by the amount of cinnamyl aldehyde they contain. That obtained from the roots is light, while that obtained from the leaves is so heavy as to sink in water.

There is but a small amount of oil in the bark, the yield being but 1 to 1.5 per cent.; six and one-half ounces of heavy oil and two and one-half ounces of light oil to eighty pounds of bark. It consists chiefly of cinnamyl aldehyde or the hydride of cinnamyl and a variable quantity of hydrocarbon. The oil derived from the coarser bark is a dark-brownish color. The oil distilled from the true bark is worth about eighteen times as much as the oil distilled from the leaves or leaf stalk or flower stalk. The latter oil is chiefly of eugenol, a hydrocarbon having an odor of cymene, a little benzoic acid and cinnamyl aldehyde. When mixed with the young twigs and cassia buds of cassia shrubs, this oil becomes a beautiful bright oil of excellent taste — characteristics which denote a higher percentage of aldehyde. Twigs show a familiar sweet cinnamon taste, but they yield a smaller percentage of essential oil than is distilled from the leaves, and has a specific gravity of 1.45 at 15 degrees C., showing 90 per cent. of aldehyde. The leaves yield sweet oil at 15 degrees C., specific gravity 1.056, aldehyde 93. Cassia buds yield essential oil 1.550 per cent., specific gravity 1.026, aldehyde 80.4 per cent. Stalk of cassia leaves, leaf stalk, and young twigs mixed yield essential oil 0.77 per cent., gravity 1.055, aldehyde 93 per cent.

The oil from the root contains cinnamyl aldehyde, hydrocarbon and ordinary camphor, and is lighter than water, both the oil of the bark and of the leaves being heavier. Oil from cinnamon bark and shoots is seldom exported. The oil is obtained in Ceylon by macerating the powdered bark or roots with a saturated solution of common salt for two days, after which the whole is distilled.

Cinnamyl aldehyde, which is a very pleasant smelling colorless liquid, may be separated from hydrocarbon, which is also found in the oil, by bringing the oil in contact with concentrated nitric acid. The crystals, which separate in long rhombic prisms or small plates, are decomposed by water into nitric acid. Free cinnamyl aldehyde may be prepared by allowing a mixture of ten parts benzolaldehyde, fifteen parts acetaldehyde, 900 parts of water, and ten parts of a 10 per cent. solution of caustic soda to stand eight or ten days, at a temperature of 30 degrees, the whole being frequently agitated. Finally the aldehyde is extracted by means of ether.

The pure Chinese cassia lignea bark, essential oil 1.5 per cent., has a specific gravity of about 1.035 to 1.060; aldehyde, 89.9 per cent., and at 15 C. should have a specific gravity of 1.050 to 1.070. On distilling, about 90 per cent. of pure cassia oil should pass over, and the balance, 10 per cent. residue, must not become solid in cooling, must not be brittle but must be in a semifluid state. If the oil contains less than 70 per cent. of cinnamyl aldehydes it may be considered adulterated, and at 75 per cent. should be handled with suspicion.

14 to 9 years old, 79 per cent. Cinnamyl aldehyde
15 years old, . . 70 per cent. Cinnamyl aldehyde
16 years old, . . 73 per cent. Cinnamyl aldehyde

Cinnamic acid occurs in the flowers of cinnamon and forms in small quantities by oxidation of the cinnamyl aldehyde when it comes in contact with the open air. It will dissolve in 3,500 parts of water at 17 degrees and is more readily soluble in boiling water and crystallizes from it in lustrous plates. From the cassia buds, refuse bark, young shoots and roots a fragrant volatile substance is obtained which floats on water, and when removed and allowed to cool, it becomes a suet, giving a delicious odor in burning, called a cinnamon suet, or wax, which is used largely by the Catholics and Buddhists in worship and at high native weddings. It was formerly used in Ceylon for making candles.

When true ground cinnamon and cassias are ex-

amined microscopically with polarized light, differences are revealed at once which are characteristic enough to distinguish the specimens, as shown in Figs. 41 and 23, Chap. III. But of the proximate chemical composition of any of the barks but little is known. Numerous determinations and analyses of the ash have been made with a view to detecting peculiarities or the addition of mineral matter. The percentage of ash is extremely variable, depending on the age and quality of the bark. Saigon chips have been known to have 8.23 per cent., while unknown cassia bark has been found with but 1.75 per cent. Cinnamon bark will be likely to average less than cassia. Fiber-like ash is very variable, Saigon yielding 26.29 per cent., true cinnamon 33.08 per cent., while unknown cassia gives 14.20; that containing the least fiber contains the smallest amount of lime.

The albuminoids are also variable; the Batavia and Saigon barks appear to contain the most. The presence of over 4 per cent. is an indication of an inferior quality.

The amount of the tannin runs extremely small, any addition of which can be readily detected. One-fourth of the ash of cinnamon is soluble in water, but less of "Cassia Vera," and less yet of cassia lignea. Little has been learned which would form a sound basis for distinguishing these barks. The presence of manganese cannot be considered as indicating that substance an essential element of the ash, nor is the fact one from which such definite conclusions could be drawn as to serve as the basis of legal testimony, but it is what gives to the different barks their different colors. True cinnamon contains less than 1 per cent. of oxide of manganese; "Cassia Vera" more than 1 per cent., and cassia lignea as high as 5 per cent.

The essential oil is but 0.5 to 1 per cent. of the bark of cinnamon and much less in inferior cassia.

We also find the presence of mucilage, coloring matter, resin, acid, starch, and lignea as well as volatile oil. Aside from the determination of volatile oil upon which the properties of cassia bark depends, chemical analysis seems to be of little value; the principal dependence

must, with our present knowledge, be placed on the mechanical and microscopic examination.

To detect the adulteration of oil of cassia by oil of cloves, a drop of the oil should be heated on a watch glass. Genuine cassia evolves a fragrant vapor possessing but a little acridity. When, however, clove oil is present, the vapor is very acrid and excites coughing. With fuming nitric acid, cassia merely crystallizes; but if cloves be present it swells up, evolves a large quantity of red vapor and yields a thick reddish-brown oil. Pure cassia oil solidifies with concentrated potash but will not when mixed with clove oil.

A good test for cassia oil substituted for oil of cinnamon is to add nitric acid, specific gravity 1.36, to oil of cinnamon (one part of the latter to two parts of acid), and shake the mixture. A bright orange-colored liquid is first obtained, upon the surface of which floats an orange, resinous substance, slowly becoming deeper in color, until a beautiful cherry-red color is visible, by which time it has changed to a liquid that floats on a lighter-colored substratum, which also in a short time becomes nearly of the same tint. Bubbles then commence to appear and shortly afterwards spontaneous ebullition occurs, with the evolution of nitrous fumes and vapors of benzoic aldehyde. By the time this ebullition has ceased the amber-colored liquid commences to clear itself and finally a clear amber liquid is left with orange globules floating on its surface. Upon oil of cassia, nitric acid, specific gravity 1.36, has a different action, as, after mixing one part of oil of cassia with two of nitric acid, a dirty green supernatant resinous mass (slowly turning brown) is seen floating on a yellowish liquid, and no further change takes place. If a large excess of the acid be added after the first addition, the resinous mass changes to a deep reddish brown and the subnascent liquid takes a cherry-red color. The same reaction occurs if a large excess of nitric acid be added to oil of cassia at first, but in neither of these cases is there any spontaneous ebullition or evolution of the nitrous fumes and benzoic aldehyde vapors.

If oil of cassia be mixed with oil of cinnamon, the reaction with nitric acid takes place as with oil of cinnamon, but more tardily, according to the amount of cassia oil present; and, at the end of the process, a turbid subnascent liquid is seen, instead of a clear one, as is the case with pure oil of cinnamon. Spirits of nitrous ether can also be used to distinguish between these oils, as it forms a clear solution with that of cinnamon, but a turbid one with cassia.

CHEMICAL COMPOSITION OF CASSIA AND CINNAMON

Samples examined, ash of the whole being about 8 per cent. and powdered 5 per cent.:

Ash Saigon,	8.23
Unknown Cassia,	1.75, extreme
Fiber Saigon,	26.29
Fiber of Cassia Cinnamon,	14 to 20, extreme
Fiber True Cinnamon,	33.08
Albuminoids Saigon,	4.55
Albuminoids Unknown Cassia,	2.45, extreme
Lime True Cinnamon,	40.09, 36.98, 40.39, in three specimens
Lime Cassia Lignea,	25.29
Lime "Cassia Vera,"	52.72
Magnesia, True Cinnamon,	2.65, 3.30, 3.86, in three specimens
Magnesia, Cassia Lignea,	5.48
Magnesia, "Cassia Vera,"	1.10

CHAPTER X

CLOVES

Your unexpanded flower-buds fair
Hold for us flavors fine and rare,
Welcome your petals in our home,
'Though Nature choose you should not bloom.

CLOVES are the unexpanded flower buds of Eugenia Caryophyllata of Caryophyllus-aromaticus, a tree belonging to the natural order Myrtacca, and are named from the French word clou, signifying nail, which it sometimes resembles.

The French word, *Girofle Cloux de Girofle;* German, *Gewurzuelken*; Persian, *Meykuk;* Sanskrit, *Lavunga;* Arabia, *Kerunful;* Bengalle, *Lung;* Malay, *Chankee, Lawang;* Portuguese, *Cravos da India;* Chinese, *Thenghio;* Java, *Wohkayu, Lawang;* Hindoo, *Laung.*

It is indigenous to the Molucca or, as they are frequently called, the " Spice Islands." It was originally confined to five of these islands, viz: Tidor, Ternate, Motir, Batian, and Kian, but chiefly to the last. These constitute a string of islands westward of the large island Gilalo and, strange to say, the clove tree does not appear to do well on the large islands, such as Gilalo and Ceram and Celebes. It is probable that Booro and the Xula Isles constitute about the western limit of the successful culture of the clove. Although it is a native of small islands, it will not do well too near the sea where it receives much moisture, or at a high elevation where it is cold. Sloping loam land is best, where there is no stagnant water, 1,000 feet elevation being the limit.

The clove tree is found outside the Moluccas and Amboina, Haruka, Saparua, and Naesalaut in the following places: Guiana, Zanzibar, Pemba, Java, Sumatra, Reunion, and West Indies islands.

CLOVES

(Eugenia Coryaphyllata of Coryaphyllas Aromaticas)

1 Zanzibar
2 Amboyna
3 Penang
4 Benconlen
5 Calyx
6 Calyx
7 Flowering stem with leaves

There are five varieties of cloves as follows:

1. The ordinary cultivated clove.
2. The female clove with pale stem, which natives call poleng.
3. The keriak or leory cloves.
4. The royal clove (which is very scarce).
5. The wild clove.

The first three are about equally valuable as spices, the female being considered best for distillation of essential oil, while the wild clove has very little aromatic flavor and no value but for adulteration.

The royal clove is a curious monstrosity, which formerly had a great reputation as the Caryophyllum regium, by reason of its rarity, and the curious observations which are made respecting it. It is a very small clove and is distinguished by an abnormal number of sepals and by large bracts at the base of the tubes of the calyx. The corolla and internal organs are imperfectly developed. In commerce the cloves are known and named from the places of growth and are graded in value in the order named — Penang (Fig. 3), Bencoolen (Fig. 4), Amboina (Fig. 2), Zanzibar (Fig. 1). They do not exhibit any very decided structural difference, but it takes 4,500 Penang cloves to weigh one pound and 5,000 Zanzibar for same weight. There also enters into commerce as a secondary product clove stalks and mother's cloves, the latter being the dried ripe fruit.

Cloves were one of the principal Oriental spices, being the basis of a rich trade from an early part of the Christian era, and the spice was well known to the ancients and certainly formed an article of commerce, during the Middle Ages, when Alleppo was the grand mart of Eastern trade.

The Portuguese discovered cloves growing abundantly on the Molucca Islands about the year 1600 and they held possession of the principal clove trade for nearly a century. Previous to this time, cloves were brought to Europe from ports in the Mediterranean, where they had been brought by Arabians, Persians, and Egyptians.

About 1605, the Portuguese were driven from the

Moluccas by the Dutch, who endeavored to control the clove trade by attempting to extirpate all the clove trees growing in their native islands, and to confine the culture of the entire production to the islands of Amboina and Ternate, paying the kings of the islands of Ternate, Tidor, and Batian a tribute to permit and assist in the extirpation of the trees.

In the years 1769 and 1771, the French, under M. Poivre, made two expeditions to the Moluccas and found the clove tree growing in some small islands which had been overlooked by the Dutch. From one of these (Guebi) they obtained plants and transplanted them to the Isle of France. In 1785, there were already between 10,000 and 11,000 clove trees growing in this island.

At the end of the seventeenth century, an Arab carried the clove seed from Baurbou and planted the plantation in Zanzibar at Miltoni, on the road to Cheuni, and plants were conveyed from the Isle of France to Cayenne, Dominica, and to Mauritius. About 1770, the English put such a high duty on spices in Dominica that they ruined the trade there, and although M. Buee planted the clove tree there over 100 years ago, one tree is yet living.

Meanwhile the Dutch, who favored the one principal isle, Amboina, selecting that part of it called Leytimeer and the adjoining Uliasser Islands, divided Amboina into 4,000 allotments. Each of these divisions was expected to afford sufficient space for the growth of 125 trees, and it was ordered that this number should be cultivated.

In 1720, a law was passed rendering it compulsory on the natives to make up the full complement, and accordingly 500,000 clove trees flourished within the limit of the small island, their annual aggregate product amounting to more than 1,000,000 pounds of cloves. One can scarcely imagine the beauty of these immense groves with their pinkish-white, snowdrop blossoms, the sweet perfumes of which are carried by the gentle breezes far out to sea.

The clove tree, owing to its noble height, fine form, and luxuriant foliage, is attractive in appearance. Its

bark is thin and smooth and its wood exceedingly hard, but it has a grayish color, which unfits it for cabinet work. It is an evergreen and in its natural state grows to a height of from thirty to forty feet, with a straight trunk, making it the most beautiful of all known trees. When four feet high, the tree spreads into several branches with fork stems, on which leaves grow directly opposite each other. The leaves are long, ovate and smooth, narrow and indented on the edge, pointed and of a thick consistency. The color of the upper surface inclines to red, as also does the stalk, while the under surface is green. The entire tree is strongly aromatic and the petioles of the leaves have nearly the same pungency as the calyces of the flowers.

In cultivating cloves, the mother cloves are best selected fresh, as they soon lose their vitality. The fruit seed (called by the natives paleny), which have become fertilized by remaining and ripening on the trees, are first soaked in water three days, or until they begin to germinate, and are next planted in a nursery of rich mold with bud end above ground in shaded beds, six inches apart if many plants are needed, twelve inches apart for few.

Two seeds are planted in each hill in the trenches, to provide for the failure of a part of the seed to germinate, and care must be taken not to plant the seed more than two inches below the surface. The nursery beds are made about six feet wide and of any length desired, and are shaded by a flat framework of sticks three to three and one-half feet high, over which is placed grass or cocoanut leaves. The ground is watered every morning and evening by taking water in the hand from the watering pot until the seeds have developed. When the plants appear above ground they are watered every other day, and when about six inches high every ten days.

The plants are kept in the shaded beds for nine months or one year, when they will be about one foot high. After this they are gradually left to the exposure of the sun by removing the framework for one or two months, when they are transplanted. Great care is taken in moving the plants. The transplanting takes

place in the rainy season. The soil is first cut around the plant by a knife or triangular-shaped spade called "moaa," "jembe," or hoe, and the plant is lifted with as much soil adhering to it as possible and is placed across two banana strips of fiber, which are three to four inches wide and one to two feet long. The four ends of these strips are wrapped around the plants and firmly tied together, and in that way the plants are carried to the place for planting. Before planting, the pieces of fiber are cut beneath at each corner and the plant is placed in holes dug for them, which are about thirty feet apart; the earth is heaped around them and the balance of the fiber at the top is removed. The plant is watered every day if it is very dry weather, and at intervals for a year, or until it is about eighteen inches high.

A great many plants usually die out and continually replanting is necessary. For this reason, a nursery is kept for about five years.

After the clove garden is planted there is no need of shading, but as the trees have only a slight hold in the ground, they are easily destroyed. They should be planted in sheltered situations. For example, a hurricane which visited Zanzibar in 1872 destroyed nine-tenths of the clove groves, but the adjoining island of Pemba did not suffer nearly so much, especially on the west side of the island, which was fairly well protected. For this reason the clove trees are protected by belted double rows of casuarina and cerbera trees. Cocoanut trees are also planted at irregular places among the clove trees. The slaves, who have their own small orchards, often plant cassava, cocoanut, and mangoes with the clove not only for shelter but to secure extra crops from the other trees. In Amboina the young trees are planted in old clove orchards for shelter, and when the young trees grow up the old trees are cut down. A clayey substratum, dark yellow or volcanic earth, intermingled with gravel and dark loam, with a small amount of sand to reduce its tenacity, is the best soil. Marshy soil is fatal. Plants obtained from a garden of self-sown seeds are the best, but sometimes young branches are laid down and kept moist, when they will take root in about six months.

Clove trees after being well rooted require but little care, and as the clove tree attracts much moisture, little other herbage will grow beneath it, but they must be kept well weeded or the trees will run into wild cloves. New leaves form in the wet season in May, the old leaves dropping off as new ones come, and soon after the leaves are out the germ of fruit is discovered and the tree begins to bear.

The clove tree needs no pruning with the exception of topping, and no manuring except by leaves which fall from the trees, which are very good fertilizers.

The flowers are of a delicate pink color and grow at the extremity of the branches. There are from nine to fifteen flowers in a cluster. These clusters, or branched peduncles, are arranged in tricahatomous terminal cymes, jointed to the branches. The unexpanded corolla forms a ball on the top of the bud between four of the calyces. The calyx is elongated and to it the ovary is united. It tapers downward and is the cup of the unripe fruit seed, giving the seed the resemblance of the clove (garafa, which is no doubt a corruption of the French word girofle).

As soon as the corolla begins to fade the calyx changes its color, first to yellow and green (Fig. 6), and then to red (Fig. 5), and, together with the embryo seed, which is about the size of a small pea, is at this stage of its growth the clove of commerce and is ready for harvesting. If it is allowed to remain on the tree three weeks longer it will gradually swell, forming an oblong berry containing one or two cells and as many seeds. It is then ripe, and is known as the mother clove (by the native, paleng). It has then lost the pungent property of the clove and will have entirely lost its value as a spice, and is valuable only for seed.

The clove, then, we find composed of two parts. The part we use is the flower clove. It is about six-tenths of an inch in length. It has a long cylindrical calyx, dividing above into four pointed spreading sepals, which surround four petals or leaves that are the unexpanded flowers. Thus the filaments are rolled into a globular bud or head of the clove, which is about two-tenth of an inch

in diameter. The parts may be seen by soaking the clove in water, when the leaves will soften and unroll. The petals are of a light color on account of their numerous oil cells, which spring from the base of a four-sided epigynous disc with angles directed towards the lobes of the calyx. The stamens are very numerous, being inserted at the base of the petals and arched over the style, which is short and sublate and rises from depressions in the center of the disc. Immediately below it, and united with the upper portion of the calyx, is the ovary, which is two-celled and contains many ovules.

The lower end of the calyx (hypanthium) has a compressed form, is solid, but has internal tissues which are far more porous than the walls, the whole calyx being of a deep, rich brown color. It has a dull, wrinkled surface and dense, fleshy texture, and abounds in essential oil which exudes on a simple pressure of the finger nail.

The clove tree is not subject to any fungoid disease, but it suffers from a caterpillar which often strips the leaves in dry weather, but the tree will soon recover after the rain sets in. The white ant also attacks the root. No remedy is undertaken for either of these pests. A worm also insinuates itself into the wood and thousands of trees sometimes perish from its work.

Harvesting should begin as soon as the fruit is at the proper stage and should be rushed with as much haste as is possible, or much of the crop may be lost by overripening. As all buds do not mature at one time, it takes about three weeks to complete the harvest.

Cloths are first spread on the ground beneath the tree. The fruit must be picked mostly by hand. Although the twigs are easily broken, the harvesting is very tedious. Four-sided ladders or movable stages are used for the lower limbs and seed poles for beating the fruit from the upper branches, which cannot be reached from the ladders. The limbs of the tree are so brittle that great care must be taken not to break them, lest the crop for the next year be injured. Boys and girls from ten to fourteen years old, are the best help for gathering the fruit. The clove and clove stems are both gathered at the same time, and are dried on mats to prevent fer-

HARVESTING CLOVES

mentation. Those which fall from the tree are dried in the sunshine. They have a shriveled appearance, dull color, little essential oil, and are of inferior value. The flowers are next dried, when they assume the brown color of the clove. The finest cloves are dark-brown with a full, perfect head free from moisture. The inferior are smaller and poorer in essential oil. The drying process is usually by simple exposure to the sun for several days on mats, but in some places the flowers are smoked on hurdles covered with matting near a slow fire. In a few cases they have been scalded in hot water before smoking. After the drying process, they are ready for packing, if they are brittle or readily break between the fingers.

Cloves are now exported in large amounts from Zanzibar and its neighboring island Pemba, twenty miles distant. They are cultivated there by all classes, from the Sultan to the humblest of his subjects. Zanzibar cloves, being very dry, do not lose much in weight by drying and may be stored for some time and will not mold, but the Pemba production arrives in a damp condition and must be sold or milled at once to save loss from shortage. The Zanzibar cloves are larger than the Pemba variety and have a reddish head by which they may be known, while the dry Pemba cloves, by reason of the greater amount of moisture they contain, have a darker color. The Zanzibar cloves, being well cultivated, are very fine, but the Pemba, having more rains, have an advantage over the Zanzibar in quantity, but they are lacking in quality. Zanzibar Island is fifty miles long by twenty miles wide, and alone produces 7,000,000 pounds of cloves annually, and Pemba a much larger quantity. Pemba is divided into two districts, Weti in the north and Chaki in the south. The two islands produce 90 per cent. of all the cloves raised in the world.

Whole cloves have a great affinity for water. Some exporters have taken advantage of the fact by attempting to place their sacks in a position aboard vessels where they may imbibe water and increase their weight, much to the detriment of the clove.

Cloves in their natural state lose from 50 to 60 per cent. in drying. One frasila of thirty-five pounds of freshly gathered cloves is equal to but half a frasila when dried. The difference in shortage between cloves at Zanzibar and on their arrival in Europe is about 8 per cent. Only about two-thirds of a clove garden is depended on for bearing, one-third being allowed for barren young trees. The tree in its native islands begins to bear when from four to five years old and is at its prime at twelve years; but in Amboina and other Molucca islands, Haruka, Saparua, and Naesalaut, it does not bear much until it is from ten to twelve years old, and it requires much more attention.

The tree yields but one crop each year, which, on an average, is about seven pounds. A good healthy orchard at maturity produces about 375 pounds to the acre, less one-third for young trees, or about 300 pounds. The yield is often fifteen to twenty pounds to a tree, and we have records of trees which bore as high as seventy-five pounds at the age of 150 years. The ordinary life of a tree is from twenty to thirty years, though it varies much in different localities. When the clove tree becomes old and worthless for bearing it will have a ragged appearance.

Cloves are shipped to native ports in hides and are sometimes exported in sacks made from split cocoanut leaves, containing 133 1-3 pounds each, called "piculs," also in twenty-two-pound packages called "kilos." They are more often exported in double mats in bags called "frales," of eighty to 100 pounds (called by the natives "mankunda"). These bags are preferred to gunny sacks, though there is more shortage, a fact which is strangely marked, since the mats, though double, admit a large amount of dampness.

The average annual consumption of cloves throughout the world has been estimated at 11,000,000 pounds. No cloves were exported from Singapore in the year 1904, but the city of Penang exported in that year $7,373.91 worth, and Colombo, Ceylon, exported 115 hundred weight of cloves and mace in the same year. A transverse section of the lower part of a clove shows a

CITY OF ZANZIBAR

VIEW OF ZANZIBAR HARBOR

dark rhomboid zone, the tissue on either side of which is of a lighter hue, which is chiefly made up of about thirty fibro-vascular bundles, another stronger bundle traversing the center of the clove. The outer layer of this, beneath the epidermis and belonging to it, we find to be a debris of no apparent structure, consisting of numerous cells and fibro-vascular bundles within their spiral vessels, with deep shreds of brown cellular matter attached. There are also tissues bordering on the oil cells. These cells are frequently as many as 300 micromillimeters in diameter.

About 200 oil cells may be counted in one transverse section, so that the large amount of essential oil in the drug is well shown by its microscopic character. Pollen grains and sometimes whole anthers are present and concretions of oxalate of lime.

The fibro-vascular bundles, as well as the tissues bordering on the oil cells, assume a greenish-black hue on coming in contact with alcoholic perchloride of iron. Oil cells are largely distributed in the leaves and petals but no starch is found in them.

The clove is very rich in essential oil, containing a greater proportion than any other plant. The oil has a greater specific gravity than water and, therefore, sinks in it. Water extracts very little of the flavor of cloves. The oil combined with resinous matter in cloves gives them their pungency, and their aromatic property depends on the amount of oil they contain.

In studying the structure of both the whole or the powdered cloves, an examination for starch in the powder should first be made in water, as the starch granules swell by the use of the chloral-hydrate solution. This solution must be used, however, as the sections and fragments will not be transparent without it.

Cloves are ground on common burr stone, but great care must be taken in grinding since they contain so much oil. The best powdered cloves present a rich meal of reddish-brown color and are a good preventive of moths, but they deteriorate very rapidly. The natives of China and India use cloves to flavor their rice; the oil is also used for medicinal purposes. Cloves,

stems, and leaves are shipped in large quantities from Zanzibar for adulterating the powdered clove and are called "vikunia"; by the native, "swahil"; French, "griffers de girofle," "peduncles de girofle"; Italy, "fustiand bastoreni"; Latin, "stiptes caryophylli."

They form a dull, gray-colored powder and yield only 5 to 6 per cent. of volatile oil, and, of course, have only a corresponding percentage of the strength or value of the true clove (the root yields 0.04 per cent.). On account of their near appearance in color and flavor to the powdered clove, and particularly for their cheapness, they are much sought for by the miller of spices, as he can thus sell his mixture at a price much below the market value of the true powdered clove. This adulterant may be easily detected by the microscope, which will reveal their thick-walled, hard, flinty stone cells and long, yellow, fibrous tissue, as similar structures are not found in the cloves in such abundance. The fruit of the clove, if added, contains starch granules, which are not present in the meal of the leaves and stems.

Often the essential oil is pressed from the whole cloves and they are then rubbed in oil between the hands and mixed with cloves which drop from the trees; both are then mixed with good cloves, and all are sold as prime stock. They are, however, easily detected by their pale color and shrunken appearance and lack of pungency. On one occasion several bags of artificial whole cloves arrived in London from Zanzibar, neatly manufactured by machinery from soft deal wood stained a dark color and soaked in a solution of essence of cloves to give them the required scent. Upon investigation it was found that this manufactured article had been imported into Zanzibar from America.

A great many flowers of plants contain the flavor or perfumes of cloves. Among these are the flowers of the lettsomia bana-nox, called by the natives of Bangal "kulmiluta." The flowers which are produced in rainy seasons are large and pure white, expanding at sunset with a strong flavor of cloves, but they wither at sunrise. Sometimes the flower buds of Dicypellium caryophyllatum of Brazil, which has a bark called clove

cassia, are used as substitute for cloves (also called Brazilian clove bark).

Cloves are largely adulterated with roasted rye and when the price of cloves is high, pimento or Jamaica pepper is often used as a mixture. This adulterant may be detected by the microscope by reason of the thick walls of the cells, which are not present in cloves, as well as by the quantity of starch granules which are not visible in the ground clove.

The essential oil of cloves is a mixture of two oils, one a hydrocarbon isomeric with oil of turpentine and the other an oxygenated oil eugenol or eugenic acid, which possesses the taste and odor of cloves, depending on the amount of eugenol it contains. This amount may be estimated by separation as follows: Shake three parts of the oil with a solution composed of one part caustic potash or soda in ten parts of water; press the crystalline paste of eugenol alkali which forms; take off the press residue with water; decompose with hydrochloric acid; wash the liberated eugenol with water, dry it with calcium chloride and then rectify.

Clove oil is often adulterated with phenol. This adulterant may be detected by shaking the oil with fifty times its volume of hot water; after cooling, it is decanted and concentrated at a gentle heat to a small bulk; then a drop of liquid ammonia and a pinch of chloride are dropped on the surface; if phenol is present the liquor will assume a green color, which changes to a blue shade, which will remain for a number of days; if not adulterated, no coloration will be produced. Clove oil is first colorless, or yellow, and darkens with age and by exposure to the air. It consists of sesquialteral and an oxygenated oil, the first passing over with vapor of water, called "light oil of cloves."

When the crude oil is distilled with strong potash of lye, its composition is $C_{15}H_{24}$, specific gravity 0.190 at 15 degrees C., its boiling point 251 degrees to 254 degrees C., its optical power being very light.

The other, which is the eugenol, is the chief constituent. Its composition is $C_{10}H_{12}O_2$. This constituent exists to the extent of 76 to 85 per cent., while very fine

may contain 90.64 per cent. in the oil of cloves, in direct proportion to the quality of the product.

Good oil of cloves should have a specific gravity of 1.067 at 15 degrees C., and should be freely soluble in alcohol at 90 per cent. An adulteration by turpentine would lower the specific gravity and diminish the solubility in alcohol. Eugenol is a strongly refractive liquid with the characteristic smell and the burning taste of cloves, and by exposure to the air it becomes brown; on fusion with caustic potash it yields protocatechuic acid convertible into vanillin by action of potassium permanganate. Eugenol is also found in pimento and in the leaves of cinnamon and of many other trees and has been artificially produced by the action of sodium amalgam on coniferyl alcohol. Pure eugenol has a specific gravity of 1.072 at 15 degrees; its boiling point is 253 degrees to 243 degrees C., and it forms a clear solution in 1 per cent. of caustic potash solution.

Clove oil has been found to contain some salicylic acid, which gives the greenish blue coloration when it is brought in contact with an alcoholic solution of perchloride of iron, and produces the intense violet color when it is agitated with metallic reduced iron. This acid may be isolated by agitating the oil with a solution of carbonate of ammonia. Caryophyllin ($C_{10}H_{18}O$), a neutral, tasteless, inodorous substance, isomeric with common camphor, crystallizable in prismatic needles, has also been found in cloves by extracting with ether cloves previously deprived of the greater part of their essential oil by a little alcohol.

Cloves also contain 16 per cent. of a peculiar tannic acid, 13 per cent. of gum, and about 18 per cent. of water and extractive matter.

The chemical composition of cloves differs to quite an extent in the different countries where they grow — Amboina, 19 per cent.; Zanzibar, 17.5 per cent.

Water,	11.00 to 2.75
Ash,	13.00 to 5.00
Volatile Oil,	21.00 to 9.00
Fixed Oil and Resin,	11.00 to 4.00
Crude Fiber,	10.00 to 6.00
Albuminoids,	8.00 to 4.00

Coffee oil is least volatile of any essential oil and is obtained from the flower buds and the flower stalks of cloves by aqueous distillation. This distillation is largely carried on in England, and the proportion of oil may amount to 16 or 20 per cent., but, to extract the whole, distillation must be long continued; the water being returned to the same material. The oil is a colorless or yellowish liquid like all clove oil, with a powerful odor and flavor of cloves, varying in specific gravity from 1.046 to 1.058. It combines well with grease, soap, and spirits, and is largely used in perfumery, and in Germany it is often adulterated with carbolic acid (phenol).

CHAPTER XI

GINGER

Ginger black or ginger white
Will furnish warmth in coldest night.
Without ginger how many would miss
A ginger cookie for little Sis.

GINGER (*officinale* (*Roscoe*) *amomum zingiber, national order zingiberaceoe Linn., monandria-monogynia*).

French, *Gingembre;* German, *Ingwer;* Latin, *Zingiber;* Italian, *Zenzevero;* Spanish, *Gengibre;* Portuguese, *Gengiuare.*

As a rule, spices grow above ground, but ginger is an exception, it being the roots or rizomes of Zingiber. The root is herbaceous and creeping, tuberous, and of a somewhat flattened roundish form, marked with rings.

It is difficult to fix the original habits of the ginger plant, and it appears to be an unsettled question as to its native country, whether it be Asia or Brazil, but in its wild state it would suggest Asia. Its history dates back to a very early period.

Vincent's "Commerce and Navigation of the Ancients" speaks of the imports of it from the Red Sea into Alexandria in the second century. It has been known in India from a very remote period, the Greek and Latin names for ginger being derived from the Sanskrit. The Greek name for ginger is conceded to have been taken from its Persian application.

Ginger is indigenous to China, and many leading authorities aver that it derives its name ginger in China, where it formerly grew abundantly, and that the plant was first called gingi at that place. It was common in the thirteenth and fourteenth centuries and was next in value to pepper, which was most common of all spices.

It was thought by the Greeks and Romans to have been a product of Southern Arabia and was received by them

GINGER. (Amomum Zingiber)

1 Leaf stalk
2 Flowers
3 Cochin ginger
4 African
5 Jamaica

by way of the Red Sea. Pliny describes it as coming from Arabia. The Romans fixed a duty on ginger, which is mentioned among other Indian spices, and ginger is mentioned in the lists of dutiable goods of the Middle Ages, showing that it constituted an important item of commerce between Europe and the East. This duty was levied in Paris in 1296; Barcelona, 1221; Marseilles, 1228. Ginger appears to have been well known in England before the Norman conquest, since it is often referred to in the Anglo-Saxon books of the eleventh century.

Marco Polo appears to have seen the ginger plant, both in India and China, about 1280, and some of the missionary friars who visited India about 1292 give a description of the plant and refer to it as being dug up and transplanted. The Venetian merchants in the early part of the fifteenth century describe the plant as seen by them in India, and, though the Venetians received ginger by way of Egypt, some of the superior kinds were taken from India overland via Afghanistan, Persia, and Turkey, and the Black Sea, then through the Dardanelles to the Mediterranean and to the European market. Francis de Mendoza is said to have first introduced it into America in 1547, bringing it from the East Indies.

There is good proof of its having been shipped for commercial purposes from San Domingo in 1585, and as early as 1547 considerable quantities were sent from the West Indies to Spain.

The plant endures a wide range of climate. It may be grown at the sea level or in high mountain regions, providing the rainfall be abundant or irrigation be adapted. It is found cultivated from the Himalaya Mountains, 5,000 feet above sea level, to Cape Comorin.

It is now found in Southeastern Asia, in some of the islands of the Malayan Archipelago, on the west coast of Africa, in South America, and the West Indies, and, in fact, almost all warm countries, including China and Japan, which are large exporters of ginger. The city of Calcutta (City of Palaces), from two words,

Kali-ghatta, signifying the landing place of the Goddess Kali, in Bengal India, exports more than any other city in the world. The finest white ginger, which is most in demand, comes from Jamaica. The acreage is not large, amounting to only 350 acres in 1891; it probably does not now much exceed 400 acres, but improved methods of cultivation have increased the average yield per acre to a large amount. Ginger is found in the following districts of India: Mahur, Massa, Patra, Darra, Kothi, Kotahi, Bagal, and Jayal. It is found throughout the Kwang-tung province, China. The district of Nan-hai, which belongs to the city of Canton, produces a greater quantity and better quality than any other of the neighboring districts. The independent tribes of the Miso-tsu, in the mountains of the northwestern border of the same province, produce much ginger, as does also Cochin China, from which the famous Cochin ginger derives its name. In the district of Hsin-hsing, about thirty miles south of the city of Chao-Ching, on the West River, three-tenths of the flatland and seven-tenths of the cultivated soil in the hills are planted with ginger. A distinction is made between flatland ginger (in Canton dialect ten-keung) which is generally soft and tender, and mountain ginger (shan keung) which is brittle and pungent.

Three kinds of ginger were known among the merchants of Italy about the middle of the fourteenth century.

The first was belledi or baladi (an Arabic name), which, as applied to ginger, would signify "country" or "wild," and denotes common ginger.

Second: Calombina, which refers to Calumbum, Kolam or Quilon, a port in Travancore, frequently mentioned in the Middle Ages.

Third: Micchino, a name which denoted that the spice had been brought from or by way of Mecca.

It is inferred from the examination of specimens of preserved ginger that are sent abroad from China that the Chinese have a species unknown in other countries. This inference is in harmony with the well-known Chinese secretiveness, a characteristic of this strange

BIRD'S-EYE VIEW OF COCHIN

CLEAN AND AIRY CHOWRINGHEE ROAD (Esplanade at Left) LOOKING NORTH OVER CALCUTTA, INDIA

people which is not only inbred but also inborn. It is possible, however, that some other plant which is not true ginger may be used in making the celebrated Canton preserved ginger, but, while this possibility is suspected, it has not been proven.

The British and American markets derive their supply of ginger from various parts of the world. The principal kinds found in commerce are Jamaica (Fig. 5), Cochin (Fig. 3), and African (Fig. 4), the Sierra Leone district producing the bulk of the African. Although each of these in its turn has several varieties and qualities, the best and most valued kind of all is Jamaica (Fig. 5), and next to it is the Cochin (Fig. 3). The Cochin when bleached resembles Jamaica to some extent. Ginger is classified into several species, as the narrow leaf, the broad leaf, and the Japanese red leaf; the narrow leaf being the most esteemed.

Ginger thrives best on rich clay or cool loam soil that is well drained. New land which has been plowed but two or three times is best adapted to its cultivation. The ground should be dug up and cleared of weeds. The plant will not grow in dry sand or hard clay soil.

Ginger, being an underground stem of tuberous-appearing roots, takes its botanical name, rhizome, from the Spanish word rais, a root. These roots are known in commerce as races, and in Jamaica as hands, from their irregular palmate form. The real roots are the fibers thrown off the rhizomes.

It is a perennial, reed-like plant, similar in appearance to our iris or flag root, two aerial stems being thrown up from each of the underground roots (Fig. 1), which soon rise above ground to the height of three or four feet. The first of the shoots thrown up bears the leaves, and the second or shorter stem, the flowers, which blossom in August (rhodon) or September. At this time the ground will be covered by the spread of the leaves which wither and fade at the close of the year, when the root is in a ripe state and is ready for harvesting. The leaves are alternate, bright-green, smooth, and tapering or lanceolate at both ends, with very short peti-

oles which gradually diverge from the stem until they are nearly horizontal, seven or eight inches in length.

The flowers are borne on the shorter separate stem (Fig. 2), averaging from six to twelve inches high at the apex of the stems. They appear in dense, ovate, oblong, cane-like spikes from two to three inches long, composed of obtuse, strongly imbricated bracts or scales with membranous margins between each bract, enclosing a single small yellowish-white sessile flower with purple or blue marking, and have an agreeable fragrance.

The ginger planting takes place in March and April when the rainy season begins. The cleared lands are made into beds with a little raised edge which forms trenches between the beds (see illustration), with openings between to allow the water to run off, for, if allowed to stand on the beds, it will cause the tubers to rot, and sometimes the beds are raised between the rows to eighteen-inch squares, two rows being planted on each ridge, the sides being perpendicular. Propagation is effected by divisions of the protuberances of the roots which are broken in small pieces, one or two inches in length, care being taken to leave at least one short bud on each cutting; they are then planted in well-broken beds four inches deep, in the manured holes in the trenches made in the beds which are nine to twelve inches apart and are shaded with bushes, which are replaced in ten days by twigs. The land must be kept well weeded during May, June, and July. It is well to cover the land half an inch deep with a mold of dead leaves, and when it rains the water will be impregnated with manure which filters readily through the leaves to the roots, and they must be kept watered in dry times.

The rhizome sometimes grows to a great size; often a single root will weigh one pound. It is a great impovisher of land and the same ground should not be used more than two consecutive years, and it is better to use it but one year. The yield is 4,000 pounds and upwards to an acre, each plant producing about eight tubers, and eight to ten times more in weight than the amount planted.

The ginger of commerce varies in form from single

MAKING A GINGER GARDEN

HOEING GINGER

joints an inch or less in length to flattish, irregularly branched pieces of several joints from three to four inches long. Each branch has a depression at its summit, showing the former attachment of a leafy stem. The color in its natural state is a pale buff. It has a somewhat rough or fibrous appearance, breaking with a short, mealy fracture, and presenting on the surface of the broken parts numerous short, bristly fibers. When young, it has a light color, internally soft, and changing to greenish. As it grows older it becomes grey outside and reddish internally. When ready for digging the texture becomes fibrous and firm and heavy, and when dried it is covered with wrinkled striated brown integuments which give it a crude appearance, which is less developed on the flat surface and, internally, it is less bright and delicate than ginger from which the cuticle part has been removed.

The best pieces of ginger root are collected at the harvest and thrown into heaps and covered with cow manure to keep the roots from drying for the next planting.

The scraped ginger, or marrow, has a pale hue and breaks readily and moderately short, the younger and terminal portions appearing pale yellow, being soft and starchy, while the longer transverse sections of the more perfect and outer parts are hard, flinty, and resinous, surrounding a farinaceous center which has a speckled appearance from the cut extremities of the fibers and ducts. The external layer of coated ginger is separated, about one millimeter broad, by a fine line from the whitish mealy interior portion, through the tissue of which numerous vascular bundles and resin cells are irregularly scattered. The external tissue consists of loose outer layer and an inner composed of tubular cells. These are followed by peculiar short parenchymatous cells, the walls of which are sinuous on a transverse section, and partially thickened, imparting a horny appearance. This delicate, felted tissue forms the striated surface of scraped ginger and is the principal seat of the resin and volatile oil, which here fill large spaces, the principal constituents being of the parenchymatous

cells loaded with starch and resin. The volatile oil gives ginger its odor; the resin, pungency. The starch granules are irregularly spherical in form, attaining at the utmost forty millimeters in diameter. Certain varieties of ginger, owing to the starch having been rendered gelatinous by scalding, are throughout horny and translucent. The circle of vascular bundles which separates the outer layers and the central portion is narrow and has the structure of the corresponding circle or nucleus sheath of tumeric. (See illustrations 12, 13, 14, Chap. III; illustration 12 shows ginger adulterated; 13 and 14 pure.) Coated ginger has usually a less bright, delicate hue than ginger from which the cuticle part has been removed, much of it being dark, horny, and resinous.

Ginger differs in quality and in commercial value in different localities. It is also influenced by the cultivation, harvesting, and preparation, but all true ginger has the same starchy, fibrous rhizome; the best quality is plump, with little or no epidermis, while the inferior quality is frequently coated and is not so plump.

Borneo or Cochin (Fig. 3) (or bleached ginger) is said to be produced by submitting the root to the action of the fumes of burning sulphur or by washing it in chloride of lime, but by chemical analysis it has been found that the bleached appearance is due to the application of common whitewash to the root, which is dusted over while wet with marble dust. This treatment, of course, injures the quality of the root.

The Cochin ginger is what is called the white ginger. It is prepared by washing and scraping the roots one at a time. This process takes much time, and the only benefit to be derived from it is that it makes the root more agreeable to the eye, and for that reason causes it to bring a much higher price.

At the time of digging the rhizomes boiling is kept in the field with frequent changing of water, and the roots intended for market are plunged into the boiling water and allowed to remain for about ten minutes. This process injures the aromatic spirits of the ginger.

At the first of the year, in January or February, the

KINGSTON, JAMAICA

harvesting takes place. The form in which ginger is harvested differs in different countries. In some countries the ginger is dried with the epidermis removed. This is known as scraped ginger. In other countries the ginger is harvested without removing the epidermis. These two forms of the product are known commercially as coated and uncoated ginger. The scraped ginger is exported mostly from Cochin and Brazil, the coated from Africa and from a district of India, and is known as Malabar ginger. It is exported from the city of Calcutta.

When the roots are first dug they are placed in baskets suspended by ropes and are pulled by two men with ropes at each end of the basket for two hours each day for two days, giving them a good shaking up to remove the scales and rootlets. The rhizomes are next spread on a raised platform to dry for eight days and are then shaken, when two more days' drying puts them in keeping state for the market. They are put up in parcels of one hundred pounds each. The product is known as black ginger.

With proper care much money might be made by cultivating ginger in India, but since this crop receives but little care it has but a small market value. The roots many times are cared for by simply smearing with cow manure. They are hung about huts to dry and become shriveled and dirty, and although they may be well smoked, they will be badly bored by the bamboo insects.

India ginger is quite similar to African and is known in commerce as Calcutta (not shown in illustration), from the city of export and is largely used for flavoring. It also is superior for ginger snaps, ginger beer, and ginger wine.

The African and Barbadoes differ from the India by the epidermis being less shriveled. They are not so hard or dark, and are sometimes scraped and bleached and made white by the chemical process of chloride of lime, a process which impairs the quality of the product but increases its market value. The bleaching and coating with gypsum or carbonate of lime is a process often

applied to old and inferior roots to make them salable by making them more attractive to the eye.

The Jamaica is the best ginger and is always told by its pale, bright-yellow color. The real marrow or white ginger (Zingiber album) is obtained from the scraped Jamaica ginger, which is free from resin and will give up properties to water very readily, a fact which makes it very valuable for medicinal use.

China preserved ginger has a more agreeable aromatic flavor than that of the West Indies, and the celebrated Canton preserved excels all other preserved ginger. The syrup waters drawn off are used for cool drinks. Canton exported for the first quarter of the year 1905 650 piculs of preserved ginger of 133 pounds each.

When the tubers are intended for sugar-pressed ginger, they are dug in early spring, while green, to obtain that which is young, tender, and full of juice. The soft, succulent, perennial rhizomes at such times rarely exceed five to six inches in length and are known as green ginger. They are buried in another place for a month and are then dried in the sunshine for one day, after which they are fit for green ginger.

Preserved ginger (*Condition Zangibaris*) is prepared by cleaning the green root, which is dug when young and tender and full of sap, before it is hard and woody, and scalding it until it is sufficiently tender. It is next put into cold water and peeled and scraped gradually, an operation which may last three or four days, the water being changed often. After this it is put into glass jars and covered with a thin or weak syrup which, in two or three days, is changed for a richer syrup. Sometimes even a third syrup is poured off for the fourth and yet thicker syrup, but not often. The syrup will be very thick and the ginger will be bright and nearly transparent. The following rule for making preserved ginger is infallible: Let the young tubers boil for twenty-four hours, then peel off the discolored and hard parts. Next boil one pound loaf sugar in six pints of water and pour the syrup over twelve pounds of the cooked ginger in a jar. Let it stand for

CANTON, CHINA

MANDEVILLE, JAMAICA

one week, when the syrup is drawn off and the ginger is again boiled and treated to another syrup like the first and left to stand another week, when again the syrup should be drawn off through a fine sieve. Return the ginger to the stone jar and pour over it the final syrup, made of twelve pints of boiling water and twelve pounds of loaf sugar, boiled and stirred until it is as thick as good honey, and will drop slowly from a silver spoon, the ginger having been previously covered with boiling water and allowed to remain until eool. It is next plaeed in the bottles or jars for which it is intended, in small pieees, as elosely as they will paek, up to the eork, so that there will be no room for air. It is then eorked with a good, new cork. Candied ginger is dried, sprinkled with sugar, and is imported in boxes.

In order to powder ginger root it must first be passed through a eracker maehine, as it is ealled, to reduee it to a proper size for feeding in a mill. The mill consists of a roller provided with very eoarse teeth, whieh revolve through similar stationary teeth; the material is retained by a semi-eireular perforated plate until it is redueed to the size of the perforation, or about the size of a eoffee bean, when it is then ready for the burr stones.

In ground ginger little of its structure is seen beyond the starchy grains whieh can readily be distinguished by their shape and by their fibrous, vascular bundles which are easily traceable. In the unseraped ginger the outer horny layer is to be seen, but not distinct in its char-aeter at any time, and when sealding of the rhizomes takes place, the starch grains are swollen and it is more difficult to find the foreign partieles. Good powdered ginger should have the fibers taken out by sifting.

The best ginger cuts pale, but bright, with a varied color, both outside and inside. Its consistency is aseertained by cutting, and varies from hard to soft or, as is termed in the trade, flinty, the soft being the best.

The popular medicinal stimulant known as Jamaica ginger extract is an alcoholic extract of ginger root, and is often resorted to by old topers who ean no longer be satisfied with whiskey.

Salable essenee of ginger is made by taking one

pint of strong tineture of the finest Jamaica, to which add in small portions at a time finely powdered slacked lime, shaking vigorously after each addition, until the tineture ceases to lose eolor, then throw the whole upon a filter and pass through the residue proof spirit until the product will measure two pints. Next add, drop by drop, diluted sulphuric acid until the rich yellow of the tineture suddenly disappears. Let it stand twenty-four hours, dilute with water to four pints, and shake with a little powdered pumice or silica and filter at 0 degrees C., if possible.

Ginger lozengers are used as a confectionery which frequently benefits dyspepsia and generally encourages flesh.

Ginger-beer powders are made by mixing two ounces of white sugar with twenty-six grains of bicarbonate of soda, five grains of powdered ginger, and one drop of essence of lemon, put in white paper. In blue paper put half ounce of tartaric aeid. In drinking use in the same way as seidlitz powder.

The following is a good recipe for making ginger beer, and it has a high medical authority as yielding a very superior beverage, and one that will keep for several months: White sugar, twenty pounds; lemon juice, eighteen fluid ounces; honey, one pound; bruised ginger, twenty-two ounces; water, eighteen gallons. Boil the ginger in three gallons of water for half an hour, then add the sugar, the lemon juice, and the honey with the remainder of the water, and strain through a cloth; when cold, add the white of one egg and half an ounce of essence of lemon; after standing for four or five days, bottle. The bottles should be laid on their sides in a eellar, and the beer is ready for use in about three weeks. If a little yeast has been used the beer is ready in about two days, but in this case the beer does not keep well.

The principal consumption of ginger is not only as a useful aromatic spice, but when applied to the nostrils it acts as an irritant and produces sneezing. The native doctors prize it highly as a stimulant. It is especially valued for paralytic and rheumatic troubles,

MONTEGO

PORT ROYAL, JAMAICA

and also for intermittent fevers. Europeans often use infusions of ginger for delicate nerves in place of tea. The green root cut into strips and steeped is thought to be superior to the dried root.

Rhizome chewed relieves toothache and powerfully increases the flow of saliva, and to the stomach it operates as a stimulant, first to the alimentary canal and, secondly, to the body in general, especially the organs of respiration. In enfeebled and relaxed habits, especially of old and gouty individuals, it promotes digestion and relieves flatulency and spasms of the stomach and bowels. It checks and prevents nausea and griping, which is sometimes produced by some drastic purgative, and a ginger plaster when applied to the forehead will relieve headache. When powdered and used with hot water and applied externally it produces a sensation of intense heat, and slight redness, and adds cordial qualities to the tonic.

Powdered ginger may be taken in doses of ten grains or more in the form of a pill or in tea. When used to excess, however, it is very dangerous, as it slowly destroys the lining of the stomach and causes lingering pain and agonizing death.

Ginger contains a great deal of alcohol. This fact accounts for the formation of the so-called ginger habit to which the victim becomes a slave as to the whiskey, opium, or tobacco habit. Indulgence in this habit is more dangerous because ginger is supposed to be harmless.

A careful qualitative examination of the character of the extracts at times may reveal the presence of an adulterant, but the chief dependence is examination under the microscope. The microscope, however, will not reveal the presence of exhausted ginger, and a careful study of the effect of exhaustion on the proximate composition of the ground root is, therefore, desirable. It would naturally increase the relative percentage of fiber and albuminoids and starch, and diminish that of the extract matter.

There is a variety of ginger known and cultivated by the Chinese under the name of *Galangal A. offici-*

narom. It is very thick and slightly flattened and is prized by the Siamese and Chinese as a substitute for ginger. In Siam it is known as Alpinia. There is also a variety found and cultivated in Siam similar to Alpinia allughas, called luk reu or bastard cardamom, which has the cardamom-like fruit. Ginger usually comes to New York in 110 to 120-pound bags and 130-pound barrels.

The yield of oil from ginger is from 1.9 to 2.7 per cent., having a specific gravity at 15 degrees C. of 0.880 to 0.885, and an optical rotation of 25 to 40 degrees in a 100-millimeter tube.

The chemical composition of ginger oil remains unknown, but it is known to contain camphene and other ingredients; its complex nature is indicated by the wide range of its boiling point.

When distilled, after drying over $CaCl_2$, the boil begins to pass over at 140 degrees C., accompanied by a few drops of aqueous fluid, the temperature constantly and rapidly rising to about 240 degrees, the chief portion of the oil coming over between 240 degrees and 270 degrees C. and a little passes over between 270 degrees and 300 degrees, but evidently accompanied by decomposition products, a transparent, brown, tenacious, semi-solid residue remaining in flask.

The lower boiling products retain the ginger aroma, which is noted when diluted with spirits, and are much more soluble in rectified spirits than higher fractions. Oil of ginger is yellow in color and its odor is intensely like that of the root; that of Jamaica is the most fragrant, but has not the burning, pungent taste of ginger, which is due to gingerol, the active pungent principle of the root.

Gingerole exists in the dried rhizomes to the extent of from 0.600 to 1.450 per cent. It is of a pale straw color and odorless, with a pungent, bitter taste. It is soluble in alcohol in even 50 per cent. dilution; it is also soluble in benzene, volatile oils, carbon disulphide, solution of potash and ammonia, and glacial acetic acid, and very slightly soluble in petroleum ether, consisting of resin, starch, mucilage, and paraffine, organic acids, oxalic acids as CaC_2C_4 cellulose albuminoids, etc.,

which constituents of ginger are found to be odorless and tasteless.

The alcoholic solution is neutral in reaction and gives no precipitate with the acetates of lead nor with lime, and does not yield glucose when treated with diluted sulphuric acid. Strong sulphuric acid dissolves it with the production of a brown color; hydrochloric acid does not affect it. Nitric acid converts it into a blood-red resinous substance.

Adulterants of ginger are sago, tapioca, flour of rice, wheat, and potatoes, Cayenne and mustard hulls, and tumeric and exhausted ginger. The foreign starches, Cayenne, and mustard hulls are easily detected, but the tumeric (East India arrowroot) cells, from their resemblance to the resin globules of the ginger, are most confusing. For detection of exhausted ginger recourse must be had to proximate analysis.

Chemical composition of ginger:

Ash may vary from 3.4 to 8 per cent.; fiber, 1.7 to 9 per cent.

The white ginger has less ash than the dark, as is also the case in regard to the percentage of fiber.

Water,	11.00 to 9.10
Ash,	7.02 to 3.39
Volatile Oil,	2.54 to .96
Fixed Oil,	4.58 to 2.29
Starch,	53.33 to 46.16
Crude Fiber,	7.65 to 1.70
Albuminoids,	10.85 to 5.25

It is said that the water and starch extract from the weight of the newly dug root 75 to 85 per cent., and yet the dried root retains all the valuable aromatic qualities.

CHAPTER XII

NUTMEGS

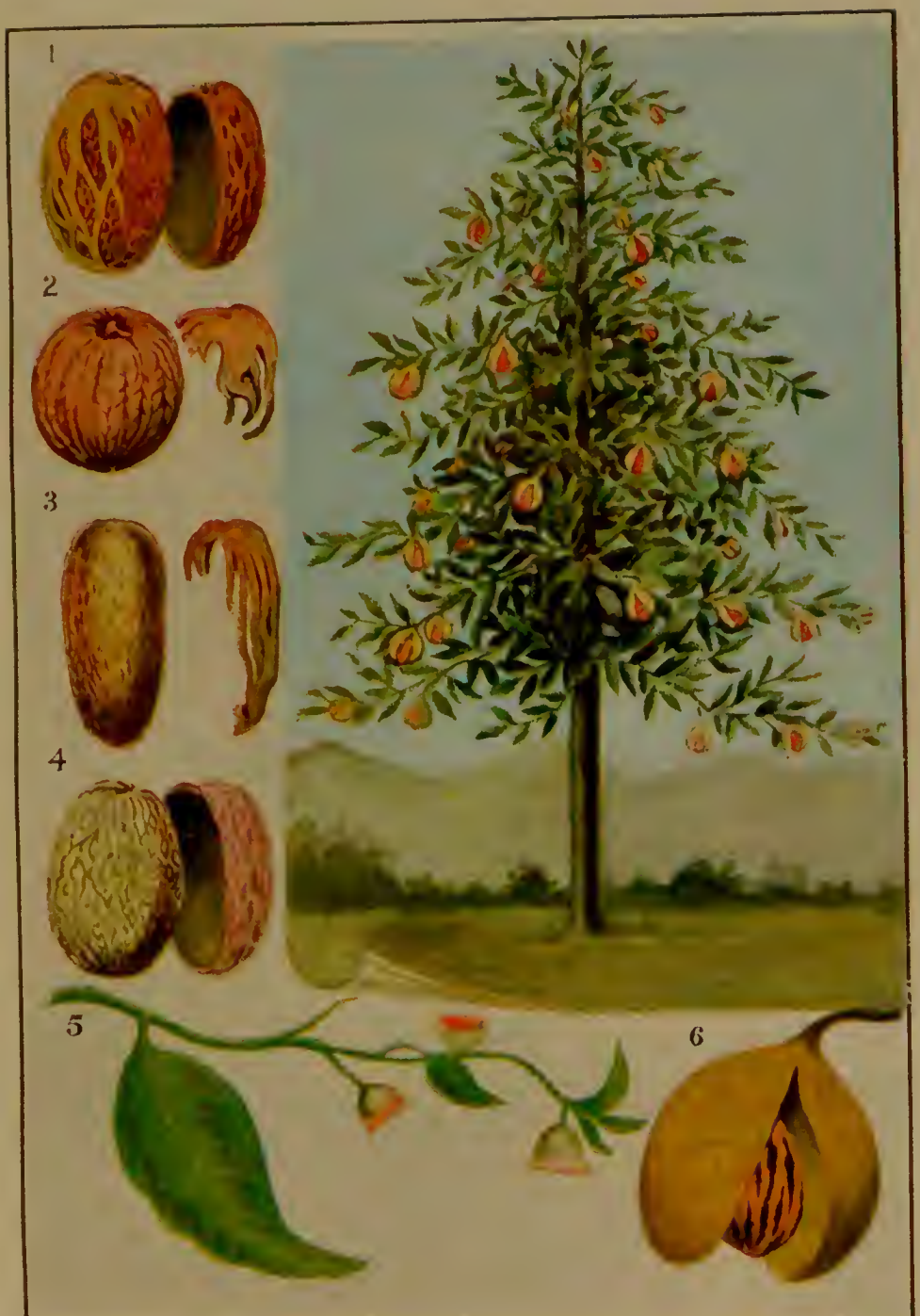
Though all your parts we rashly grate
To particles most fine,
You yet return for cruel strokes,
Tears filled with perfume fine.

NUTMEGS are the fruit of *Myristica fragrans* (natural order *Myristicaceoe*) *maschata officinalis.* Myristica is founded upon the Greek word myrrh, myristikas, sweet smelling, and belongs to the custard family.

Italian, *Nace moscada;* French, *Muscades et macis* or *Naix muscade;* Portuguese, *Noiz mascada;* German, *Muskatnusse* and *Muskatbluther.*

The nutmeg was known by the Persians (as jouzbewa) and by the Arabians (jowzalteib) in the eighth century. There are about forty different species. Although the name myristikas (sweet smelling) was given to the genus on account of the odor of its fruit, there is a material difference in the several species, the commercial value of the fruit depending upon the degree in which the essential oil producing this perfume is present.

The true nutmeg is the kernel, mostly consisting of the albumen of the fruit or the seed of a diœcious evergreen tree, which in some countries, as in New Guinea, grows from fifty to sixty feet high. It is a native of the Molucca Islands. The nutmeg gardens of the world are the Banda Islands belonging to the East Indies, but the nutmeg is also found in the West Indies on the Island of Jamaica, which is quite noted for its nutmeg plantations. Nutmegs are also found in Bengal, Singapore, Penang, and French Guinea and Brazil, in the west peninsula of New Guinea, Damma, Amboina, Ceram, Boro, Boero or Bouro, Gilolo, Sumatra, and they have been successfully introduced in Ternate, Menando, in



NUTMEG. (Mysistica)

1 Nutmeg with Mace and part inner shell.
2 Brown Pedang
3 Long Macassar with Mace
4 Singapore or Batavia
5 Flowering twig with leaf
6 Burr just opening showing the Mace

the Celebes group, and in Java and Bourbon or Reunion, but not in the Philippines. They do not do well except between 12 degrees north and 5 degrees south of the equator. They are found growing wild in the Banda Islands, to which they are indigenous. Three of these islands are noted for their nutmeg gardens, viz: Great Banda or Lantor (Lantor Banda), Pulo Nera, and Goenong Api. The three islands together contain thirty-four parks, of which Great Banda has twenty-five, Goenong Api six, and Pulo Nera three.

These parks contain 319,804 bearing trees, which produce annually about 4,000 piculs of 139½ pounds each of nutmegs, and 1,000 pounds of mace. This yield gives about one and one-half catties of 139 pounds each of spice to each tree per annum. But much of the fruit is lost on account of the height of the trees, and the inaccessible places in which many of the nuts fall. Many drop into the streams and float away, and many are lost by being worm-eaten, also many are eaten by field rats. The entire group of Banda Islands is comprised within a space seven miles long and three miles wide; in fact, these are the dimensions of the Island of Lantor itself. The islands are of a light volcanic soil, and the great moisture, due to the numerous rains, makes them most favorable for nutmeg raising, and seems almost perfectly to suit the requirements of the tree. The only cultivation required is to keep the grass and weeds and underbrush cut, no manuring or artificial stimulus being needed. Almost the entire surface of the islands is planted with nutmeg trees. The labor is performed by Dutch convicts, who are banished to these islands, there being no native population.

Plants which spring up spontaneously from the seed are taken up and transplanted by simply heeling in the ground of the required vacancy. In some places clumps of trees are found growing not more than ten to twelve feet apart under the shade of the canarium commune. In fact, the nutmeg is more collected than cultivated in the Banda Islands. The trees grow from fifty to sixty feet high, while those of the Straits are but a shrub in comparison, and in other countries they

grow only from twenty to forty feet high, and need much manuring and very careful cultivation. It would appear as if the trees were overshaded in the Straits, and yet they require much shade to protect them from the strong winds which prevail there.

When a nutmeg plantation is to be started, great care must be taken to select a good, rich, virgin soil, formed of a deep loam with good drainage, as the plants will not thrive on a sandy soil. The rainfall should be at least from sixty to seventy inches per annum. Although the nutmeg plant is essentially a lowland plant, flourishing from two hundred to four hundred feet above sea level, and not proving successful at a higher elevation than fifteen hundred feet, it must be kept free from stagnant water about its roots, for this would surely kill it. Virgin forest lands, with a soil covered with a layer of leaf mold or rotten wood, is well adapted to the cultivation of the plant, and a hot, moist climate is requisite. Plenty of shade is necessary to protect the trees from the prevailing winds which would scatter the flowers and uproot the trees, as the roots take but a slender hold in the ground. Large trees should not be allowed to grow with spice trees, as they would exclude the vivifying rays of the sun and arrest the fall of the night dews, which are necessary for quantity as well as quality of the nutmegs. Large trees would also rob the soil of its richness. A double row of casuarina littorea and cerbera manghas planted at the windward side of the plantations will afford ample shade and protection from the winds, and trees with these advantages will give good crops.

Plants are raised from the largest, round, fresh nuts before they will rattle in the shell, care being taken that they are not more than two months old. They may be planted and staked in the field intended for the plantation, about eight feet apart. If they are kept well watered and manured, such planting is preferred to sowing in a nursery. Plants raised in a nursery are usually sown in bottomless baskets about one inch below the surface in a place well sheltered from the winds.

The nurseries must be kept free from weeds and well

watered every day in dry weather, especially when the seeds are planted in bamboo baskets, for should the earth become hard and dry the nuts will not germinate. If the land has been well tilled the seedlings will appear in about sixty days. When they are from three to four feet high they may be transplanted to a permanent situation. This should be done during wet weather and the trees must be kept well manured. They must be watered on alternate days and protected from the sun. They must be cultivated for five years. Care must be taken not to strike the roots of the tree in cultivating, for if the tap root is broken the tree is sure to die. When any roots become exposed they should be covered with leaf mold or with dirt mixed with cow manure. When well started, the trees should be thinned out, leaving them from twenty to thirty feet apart, according to the richness of the soil; the richer the soil the wider the space. Before the transplanting of the seedlings from the nursery, holes are first dug and left open for a time and filled with surface soil consisting of cow dung mixed with burnt earth, but if the ground is very rich the manure may be dispensed with. The holes prepared in this way give the young plants a good start. The trees are planted in prepared holes in the bamboo baskets as they are taken from the nursery, slit down at one side. Banana plants make good shade for young trees and return good profit until they have to be cut down to give room for the growing tree. When the trees are backward in growing they should have extra care. The soil about the roots should be loosened and manuring should be done with farmyard compost lightly scattered around the trees close to the stem, so that it may work its way into the soil. To dig holes would injure the roots and might cause the tree to die.

In very dry weather it is well to cover the ground around the trees with dry leaves to protect them from the sun's rays and to keep the moisture in the ground. On poor soil the trees must be kept manured until they are fifteen years old. They need as many as ten large baskets to a tree. The manure should be at first spread in the sunshine to kill all the insects it may contain.

All parasitic and epiphytic plants which may attach themselves to the stem and branches should be removed at once, as they would have a most injurious effect.

The pruning operations are very simple. All suckers should be cut away and the lower branches should be removed gradually until there is sufficient space for working under the trees. The nutmeg trees are monœcious as well as diœcious. The sex of a tree cannot be told until it flowers, which will be in about seven years, when, on cutting the flower open longitudinally with a sharp pen-knife, the sex may be determined. (See illustration.)

The staminate flowers are from three to five, or sometimes more, on a peduncle, and the pistillate flowers are often solitary, both kinds of flowers being small and of a yellow color (without calyx), and the perianth is bell-shaped with three or four teeth at the top.

The anthers are set around a central column, and if the flowers be fully open the yellow pollen may be easily seen in the pistillate or female flowers, in the form of a little red disk knob. Soon after the fecundation of the embryo the female flower drops off and the little knob expands, gradually increasing in growth.

Fig. A, verticle section of male flowers.

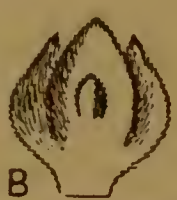


Fig. B, verticle section of female flowers.

It will be noticed that the pistil is shorter than the perianth and is swollen at the base and crowned with the stigma which is indistinctly cut into lobes. It is a good plan to plant two nuts or transplant two seedlings in one hole about two feet apart, and when the flowers appear it will seldom happen that both trees will be male trees.

After determining the sexes the cutting out of the surplus male trees should take place. Those which are

to remain should be left as much on the windward side of the plantation as possible, so that the pollen may be carried by the wind to the pistils of the female trees. In this respect the parks are similar to our apple orchards. If a surplus number of male trees be left growing, they are topped, or headed down and grafted with scions from the female tree.

The parkineers* on the Banda Islands do not expect a yield above 30 per cent. of male trees from the planted seed, and seldom so many, and they think 2 per cent. enough male trees to leave growing, while other countries look for a yield anywhere from 8 per cent. to 75 per cent. of male trees, and they estimate one male tree to eight or ten female the right proportion.

The nutmeg tree is a handsome, bushy evergreen with straight and lofty undivided trunk, and with reddish-brown bark and verticillate branching head, much resembling our apple tree. It is cut back in the Straits to about twenty feet. The bark on the young branches is bright green, the dark, shining leaves, glossy on the upper surface and whitish below, are alternate, simple, and entire and oblong and obliptic and very aromatic. They are strongly veined, the petiolate being devoid of stipules or having very short foot stalks.

The nutmeg tree will begin to bear when from five to six years old and will then produce from five to six pounds of nutmegs and half a pound of mace to a tree. The yield is more profitable when the tree is ten years old. The tree will continue to produce fruit at sixty years of age, and has been known to bear a crop when one hundred years old. The male tree has a much shorter life than the fruit-bearing trees. The flowers are very small and are clustered in the axils of the leaves. They are a pale yellow and have a fragrance much like that of the lily of the valley.

The nuts will often split before reaching maturity, by reason of cold, damp weather and sudden changes. The nutmeg tree, like the orange, is a constant bearer, producing two crops in one year, and sometimes three,

* The parkineers is a term used in the Banda Islands.

in the East. A much larger crop, however, is harvested in the later months of the year, and the smaller crops in April, May, and June, and even in July. Some are harvested every month of the year, as is the case to some extent on the Banda Islands, and they are delivered every month to the government boats. But the months especially devoted to harvesting are the same on the Banda Islands as in the Straits Settlement. From the Straits the shipments are made quarterly.

The nutmeg fruit is about three inches long and about two inches in diameter, and is found intermingled with the flowers of the tree, it requires from six to nine months to mature; fruits all the year around in a hot, moist climate. In the Banda Islands the fruit hangs upon longer and more slender stalks than is the case in the Straits Settlement. The fruit hangs pendulous from the tree and is fleshy and firm. At first it is round or oval and smooth, much like a damson plum, but it soon takes on the marked longitudinal, dented line and pale green color — characteristics that give it more the appearance of a peach or an apricot. It finally changes to a golden or yellow color and to the shape of a pear when ripe. This outer covering, which is at first thin, gradually grows fleshy, abounding in an astringent mass which becomes dry and leathery, at which time it bursts open into two valves from the apex, disclosing a brilliant scarlet aril or net-like membrane, revealing the nutmeg kernel, which is closely invested in a thin brown shell, which separates the kernel from the aril or mace which envelopes both.

In the early days the Dutch owned the Banda Islands. They attempted to control the nutmeg trade. Accordingly, they used to heat or lime the kernels before shipping, to keep them from sprouting and so to prevent the propagation of the trees. At one time they burned three piles of nutmegs, each as large as a church, to keep up the price. But Nature did not fancy this kind of business and a large pigeon, called the "nutmeg pigeon," also known by the name of walor and nut eater (species of carpophoga), was attracted by the bright color of the mace and, feeding on it extensively, swal-

HARVESTING NUTMEGS

lowing the mace and rejecting the nutmegs, accomplished what the Dutch tried to prevent, by planting the nuts in all the surrounding countries of Penang, China, Ceylon, and India. Thus the world at large was benefited.

The brown shell which covers the nutmeg has about one-fourth the weight of the nutmeg kernel. When the nutmegs are exported without removing the shell they keep better, but the cost of freight to the importers is increased.

The nutmeg fruit includes, first, the outer or fleshy membranous part; second, the substance covering the inner shell of the nutmeg, known as mace; next, the inner shell; and, finally, the kernel or nutmeg.

The native women and children gather the fruit twice each day, except Sundays, from under the trees and carry them into the boucan, barn, or sheds, made of brick with terraced roofs, rejecting the outer shell or husk. In the Straits Settlement, if the trees are not too high (the highest tree not being over thirty-five feet on Penang Island), the nuts are beaten off by means of long bamboo poles. In the Banda Islands the fruit is gathered by the use of a neat oval bamboo basket, partly open at the top, furnished with a couple of prongs. With these prongs the harvester catches the fruit stalk and by a gentle pull causes the nuts to fall into the basket, which will hold three or four. By using this method the mace will not be bruised as it would be by falling to the ground, and they have a skin more free from blemish, and it is thinner compared with the fruit and of a well-uniformed proportion.

The outer shell or husk, which is harder than that of a filbert, is removed by one man placing the nuts on a sort of a drum head and another beating them with a flat board, a process which will not bruise the nuts. One man will beat out as many in this way as six men can do in the way which is employed at the Straits. After the envelope of the curious, red-colored network (mace) is taken off the nutmegs are placed in receptacles which have fine wire-mesh bottoms, made of splints, called by the natives neebongs, to allow the air to pass through, or,

by being elevated above each other, they are kept before a fire for a month or more, the first elevated being about ten feet from the ground. After this they are exposed to the sun two hours each day for two or three days until they rattle inside the shell when shaken. They cannot be removed when green without damage to the nut. They are then cracked by beating with great care, as hard blows would cause a black spot on the nuts, affecting the sale. They are then assorted into three grades, the finest are exported, the second are reserved for home consumption, and the third grade, made up of small, damaged, or unripe stock, are burned or used for nutmeg butter. Nutmegs are often affected by black spots or gangrene on the outer covering, caused by an insect, which deposits its larvæ on it in the husk and feeds on the saccharine matter of the outer covering until it bursts, when it makes its way into the soft nut itself.

The number one nutmegs are put up in half piculs (heavy-made boxes) containing sixty to sixty-five pounds. The ovate nutmeg seed is marked with impressions like the lobes or arillus (mace) which covers it, one side being of a paler hue and slightly flattened, and having the shape of the outer shell, with corresponding dimensions in size, the largest being about one inch long by eight-tenths of an inch broad. Four such nuts will weigh one ounce. They are of a grayish or brown color, but they are coarsely furrowed and longitudinally veined, and are marked on the flatter side with a shallow groove.

There are only three kinds of nutmegs generally known to the trade. The darker brown, which is the fruit of the myristica fragrans, is cultivated in Penang and is known as the Penang nutmeg. It is exported from the city of Penang (Betel-nut City, Fig. 2). The pale-brown, lined, Singapore or Batavian (Fig. 4), is named from the city of Batavia, on the Island of Java, from which this variety is exported. The long, slender, wild nutmegs (Fig. 3) are known as Macassars, from the city of Macassar (called by the natives Mangkasara) on the Island of Celebes, the principal city of export. But the three kinds are distinguished by the planters as

male or barren; second, the round female (nux myristica fœmina or green) (nux maschata fructo rotundo), and the royal.

The royal nutmeg is no larger than a peanut (nux maschata rigia) and produces the long nut which has the aril or mace much longer than the nut, while the true queen or female, which is the more valuable round nutmeg, has its mace extending only half way down the nut.

The average yield at six or seven years, at which time the trees begin to bear, is five to six pounds, and a ten-year-old tree will produce from ten to fifteen pounds, and will cover an area of about five hundred square feet. This yield, at forty cents per pound, including the mace, would bring $300 per acre, besides the other ingredients yielded, which are valuable. The older the tree the greater the yield, and, of course, the tree is valued accordingly. There is a tree on the Island of Jamaica which bears over 4,000 nutmegs every year.

Nutmegs vary greatly in size, running from 60's to 120's as follows: large, 60's to 80's to the pound; medium, 85's to 95's; small, 100's to 130's. There are probably more of the 110 size used than of all other sizes combined. Nutmegs are assorted into the several sizes found on the market by passing them over different mesh sieves. This process is called garbling.

The Penang nutmeg, the fruit of the myristica fragrans, called by the Hindustanee and Bengalee jaiphal, or true nutmeg, as its name implies, which is the finest, is of a brown color and shaped like a damson plum. It is furrowed on the interior and grayish inside, with veins of red running through it, and possesses a fine, delicate aroma of great strength and flavor. The Penang nutmegs are not to be found in the spice-mill stock because the poorer Batavia or the wild Macassars will grind better, their worm holes will not show in the meal, and they are not difficult to powder. Liming nutmegs by the Dutch to prevent their sprouting has lead to misunderstanding and many vices. Some think limed nutmegs the best, taking them in preference to the fine, brown Penang, and are willing to pay higher

prices for them. Such buyers seem to know nothing about the convincing, easy tests that may be made by weighing, the pure nutmegs being heavier on account of the oil they contain, and by scraping the nut with the finger nail to note if the oil starts.

Although there are only four kinds of nutmegs known to the trade there are more than twenty-five (many give as many as forty) different varieties. Those known to commerce, when found in the order of their quality, are as follows: The Penang, of which there were exported in 1904, 2,828 piculs, valued at $175,592, which are unlimed and are brown; second, Dutch limed or Batavians; third, Singapore, which are a rougher, unlimed, narrower kind, and of somewhat less value than the Dutch Batavia; fourth,* "long" or "wild" or "male nutmeg," nux myristicamas, Clusius (nux maschata fructo oblongo C. bouchin), which is the product of myristica fatua. In addition to these, we have the Malabar, found in the district of Malabar, province of Madras, British India, which is the product of myristica Malabarica. It resembles a date in size and shape, and is closely allied to the long nutmeg, but has less flavor. It is called by the Hindustanee and Bengalee jaiphal, and those of myristica Malabarica, "ran jaiphal," and "ramphal," and in the native Malabar dialect, "panam palka," and is largely used as an adulterant for powdered true nutmeg.

The wild nutmeg (myristica argentea) tree grows very high with a leaf equal in size to the horse chestnut, with a silvery top, and in Germany it is called the "horse nutmeg." It is found in New Guinea, Amboina, and the Banda Islands. The nuts, when fresh from the trees, are about four and one-half centimeters to six and one-half centimeters in length, and four and one-half centimeters to five and one-half centimeters in diameter. They are first of a bright red, but later scattered yellow-brown veins or specks appear which contain the aroma. After the husk is removed, the nut is about three and one-half to four and one-half

* J. C. Sawyer's Odorographia, Second Series.

HARBOR OF MACASSAR, CELEBES ISLANDS

A FOREST

centimeters long and from two to two and one-half centimeters in diameter, and the testa is nearly one millimeter thick. They abound in a disagreeable oil, which, of course, will rob them of the pleasant nutmeg flavor which is found in the cultivated nut. The thick pericarp or outer covering is hard and brittle. The mace which covered it is insipid, is of a reddish color, has a disagreeable odor and it generally consists of four stripes which are united above and below. It is broadest at the base, gradually narrowing toward the end.

The fruit is elongated, or ellipsoidal, rusty, tomentose, in shape like a date, and differs from the true nutmeg in being less marked by the arillus furrows. The cotyledons are joined in a disc swelled at its edges to five millimeters diameter, and the endosperm contains much starch.

Myristica argentea nutmegs are sometimes used medicinally for dysentery, headache, and other ailments, and those long nutmegs (male), wild myristica tomentosa (myristica fatua), are next in flavor to the true myristica fragrans, and are the kind sold in the market as Macassars. Another kind scarcely worthy of mention is the myristica succedanea, a variety found on the Island of Tidor, which is very similar to the myristica fragrans. Other so-called nuts which rarely figure in our market except as a substitute to adulterate are the American, Jamaicans, or Calabash (monodora myristica), Brazilian (cryptocarya maschata), Californian or stinking (torreya myristica), Madagascar or clove (agathophyllum aromaticum), Peruvian (laurelia semperviren), Plume (atherosperma maschata), Sante Fe (myristica otoba) of New Granada and the myristica sebifera virola sebifera aublet, the seed of which furnishes an abundance of aromatic yellow tallow which has a crystalline appearance and is suitable to manufacture into candles. All of these varieties are not much better than the wooden nutmegs from the Nutmeg State, or the one made by the heathen Chinese out of sawdust and clay.

Batavia nutmegs are often attacked by beetles or are worm eaten. In this case they are pickled in lime water made from calcined shell-fish and mixed with water

until it is of a semi-fluid consistency. Into this mixture they plunge the nutmegs (which have been put in bamboo baskets) two or three times until they are completely covered with it. Next they are put in heaps and are allowed to sweat. After this they are packed in boxes or barrels made of the best Java teak for exportation, with the worm holes plugged up. Sometimes it is thought quite necessary to lime the Batavia nuts (the kind most commonly used) before shipping, not only to protect them from the ravages of the beetles or worms which attack them, but also to prevent germination. But it has been proven that this process is perfectly unnecessary, as a simple exposure of the nuts to the action of the sun is sufficient to destroy the vitality of the embryo. It is also proven to be unnecessary, since the true brown Penang is shipped without liming. If lime is used, however, it should be in a dry state. After all that has been said, it is evident that the dealer or the consumer must be either foolish or ignorant who will reject the fancy, round, brown Penang nutmegs for the limed Batavia because it pleases the eye, and will for no other reason buy old worm-eaten nuts with plugged-up holes, relimed to give them a new appearance. The new coat of lime costs but little, but when the case is empty there is found from one to two pounds of lime in the bottom, not covered by tare, which has cost the purchaser the price of good nutmegs. Just so long as the trade will demand this class of stock, just so long will deception be practiced and inferior stock will be found on the market.

All nutmegs have a market value and must be sold. In selecting stock, pick out of a lot the most inferior looking nut and cut it into two parts. If it cuts firm like wood and has plenty of oil and no worm holes, there is not apt to be any danger of inferior nuts in the balance of the stock.

In using nutmegs always grate from the flower end instead of the stem end.

Good, fresh nutmegs cannot be ground by an ordinary burr stone, such as is used in spice mills, but must first be broken or cracked in a cracking machine. This

machine consists of a roller provided with coarse teeth which revolve through similar stationary teeth, the material being retained by a semi-circular perforated plate until it is reduced to the size of the perforation or about the size of a coffee bean. After this it is pulverized by pounding or by stamps, as they are called, in the same way that mustard seed is pulverized. Sometimes the nuts are extensively mixed with some dry, foreign material, in which case they may be ground on the burr stone by an experienced miller. One or two stamps may be used in powdering nutmegs and mace, two being about all one man can well handle. Powdered nutmegs soon lose their flavor by standing, on account of the loss of oil, but as they have the consistency of tallow, the flavor is for a time preserved.

Nutmeg butter or balsam of nutmeg is often obtained by powdering the broken nuts, when fresh, to a fine powder or paste, and then steaming them for five or six hours. The substance is then put into bags, placed between heated iron wedges or plates and is subjected to a strong pressure, which presses out the fluid (though this is sometimes extracted by ether or alcohol), which is about 20 to 25 per cent. of the mass. Ten to 12 per cent. of this fluid is an orange-colored oil, which gives it an agreeable odor. When it is cold it becomes somewhat spongy and has a marbled or mottled appearance. It becomes hard with age and is exported in small bricks, ten inches by two and one-half inches, wrapped in palm leaves. It is known under several names, as nutmeg butter, balsam of nutmeg, concrete oil, or the mace oil of commerce (French, *beurre de mascade;* German, *masket butter, muskatnussal*), and as Banda soap, sometimes made from the distilled nutmeg leaves. It has an agreeable odor and a greasy taste, melts at 45 degrees C., and dissolves in four times its volume of warm alcohol, 8 per cent. pure, or in two parts warm ether. The Banda soap is soft to the touch, has a yellow color, and is sometimes counterfeited by using a foreign fatty substance, as palm oil, suet, wax, and animal fat, boiled with powdered nutmeg and flavored with sassafras, which gives it the right color and flavor. The

best nutmeg oil is imported from India, often adulterated by the distillation of the leaves of the eucalyphus alba, which has a nutmeg odor and flavor. The fleshy part of the nutmeg fruit is often preserved in sugar and eaten as sweetmeats.

London's annual import of nutmegs is 400,000 to 800,000 pounds, and of mace from 60,000 to 80,000 pounds. An amusing incident is told of an English governor sent to the Isle of Ceylon who, noting the statistics that nutmegs were very abundant and cheap, and mace was scarce and high, called his council together and said: "We must raise less nutmegs and more mace."

The tissue of the seed can be cut with equal facility in any direction. By the microscopic study of a transverse section of a cut nutmeg we find the testa consists mainly of long, thin, radially arranged, rigid cells, which are closely interlaced and do not exhibit any distinct cavities. The endopleora, which forms the adhering coat of the kernel and penetrates into it, consists of soft-walled, red-brown tissue, with small scattered bundles of vessels, thereby imparting the peculiar marbled appearance so familiar in a cut nutmeg. In the outer layer the endopleora exhibits small collapsed cells, but the tissue which fills the folds that dip into the interior consists of much larger cells. The tissue of the albumen is formed of soft-walled parenchyma which is densly filled with conspicuous starch grains and with fat partly crystallized. Among the prismatic crystals of fat, large, thick, rhombic or six-sided tables may often be observed. With these are associated grains of albuminoid matter, partly crystallized.

In carefully made preparations from the whole nutmeg, the structure above described may be made out by care and patience, but in the ground only the interior parenchyma cells with their starch contents can be seen when mounted in water, with the alternate use of common and polarized light. The fatty crystals are not observed and the fragments of the endopleora, or red-brown tissue, are only detected by their colors.

In chloral-hydrate the starch cells and grains are swollen, but the red-brown tissue is much more trans-

parent, sufficiently so, in fact, to reveal any differences between it and any adulterant which might bear a resemblance. There are but few bundles of fibers to be found, and the structure as a whole will be found so simple that the addition of any foreign material can be readily detected.

The nutmeg owes its flavor and aroma to the oil it contains, which is soluble in alcohol and may be obtained by distillation of the pulverized nuts, the yield being from 8 to 10 per cent. The oil is straw colored, with a specific gravity of 0.093, consisting principally of a hydrocarbon, $C_{10}H_{16}$, boiling at 165 degrees C. This appears by research to be a mixture of at least two hydrocarbons — one a terpene, boiling at 163 degrees; the other, ordinary cymene, the cymene being extracted by treating the mixture of hydrocarbons with sulphuric acid, whereby the terpene becomes resinized and, on distillation with water, the cymene passes over unaltered; when purified, this was found to be identical with all the other known cymenes.

Oil of nutmegs also contains an oxygenated constituent, termed myristicol, whose assigned formula is $C_{10}H_{14}O$, boiling near 212 degrees. Examined by polarized light in a 200-millimeter tube, oil of nutmeg, distilled, was found to deviate the ray 15.3 degrees to the right, and oil of long nutmeg 28.7 degrees to the right.

A more minute analysis might be given, but enough has been said to meet all requirements for distinguishing between the pure and the adulterated nutmegs. To add more might be confusing, and, since at present nutmegs are almost entirely sold whole and grated in the kitchen, attempts at adulteration have been very few.

Chemical composition of nutmegs:

Water,	6.08	Starch, etc.,	36.98
Ash,	3.27	Crude Fiber,	11.30
Volatile Oil,	2.84	Albuminoids,	5.16
Fixed Oil or Fat,	34.37	Nitrogen,	.83

CHAPTER XIII

MACE

With your colors shining bright,
You stopped the pigeons in their flight;
From Dutchmen's fields they planted seed,
Which brought forth wealth in time of need.

ALTHOUGH nutmegs and mace are the fruit of the same tree, and although they have similar properties, they are yet so different in growth and flavor as to justify giving to them separate chapters.

The fleshy scarlet mantle or arillus which envelopes the nutmeg (illustration under nutmeg), or the coat between the outside periearp and the seed of the nutmeg, is called maee (Latin, *Macis;* French, *Macis;* German, *Maker*). It is not a continuous coat, but a network whieh varies in amount in different loealities, as well as on the several speeies of nuts, being from 0.25 per eent. in the Bandas to 10 per cent. in Jamaiea. It would, therefore, require from ten to 400 pounds of nutmegs to produee one pound of mace.

Planehon says of this laciniate envelope that it is nothing more than an expansion of the exostome and, therefore, an arillode or false aril.

Maee is harvested at the same time as the nutmegs and sometimes it is removed from the nutmeg by seraping with a knife, but removing it by hand is eonsidered the better way. This is done by eommeneing at the base of the nut, for the reason that there the interlacing or lining becomes more expanded and at the same time flattened. In this eondition it is plaeed on mats or trays to dry in the sunshine. The modern drier, however, is now largely used and is preferable, even when the weather is elear for a sufficient time to eure the maee, as sunshine seems to absorb some of its substantial qualities. The modern drier also prevents it from drying too rapidly. Maee, in drying, is first erimson, then

blood red, but in process of drying it loses this tinge, and after a few months, when properly cured, it is of a yellowish or golden-brown color, preferred by the dealers. It is then firmly packed in bags (called by the Germans in the Straits Settlements, *sok kols*). The Banda mace is usually packed in one-half piculs of sixty-five pounds and in barrels or casks containing about 280 pounds each, the pressure being about equal to the weight of the mace. When driers are not used and the weather is wet, mace is dried by being smoked, care being taken not to blacken it. Sometimes the base of the mace is cut off and it is dried in double layers — a process which many think has a tendency to keep worms from working into it, but this is not true, as it, instead, furnishes a place in which they can hide.

True mace is the product of the true nutmeg, which is round and covered with single and double blades of flat and somewhat irregular smooth slits. These are slightly flexible or brittle membrane of a golden-yellow color, and, in the odor and taste, analogous to the odor and taste of the nutmeg. They are rich in fixed and essential oils and in aroma. While each is a part of the same fruit, the nutmeg and mace are entirely different in outward appearance and are separated for commercial purposes, as well as for their separate uses.

The Penang mace is most esteemed because it is flaxy and spreads. Penang exported 1,143 piculs, valued at $105,032, in 1904. The Dutch or Batavian is more fleshy and cheaper. The Singapore is inferior to both the Penang and the Dutch, while the wild or false mace from the long nutmegs is dark red and has a coarse, strong flavor, which is very different from that of the true mace.

*Myristica Malabarica, known under the name of Bombay mace, used to adulterate the true powdered mace, is much larger and more cylindrical than the arillus of the true nutmeg and has several flaps united at the apex, forming a conical structure. The anatomical structure is also different, as may be seen by

* Tank Bedd, G. L., Sylv. t269; Rheede, Hort., M21, iv, t5.

the aid of a microscope. When moistened with hydrochloric acid, the Bombay mace presents the marked peculiarity of assuming a greenish color. Bombay mace may be detected by boiling the suspected samples with alcohol and filtering through a white filter; if the mace is pure the filter is stained a faint yellow, but if Bombay mace is present the filter, especially the edge, is colored red. A rather more delicate test is to add "Goulard's"* extract to the alcoholic filtrate; with pure mace only a white turbidity is occasioned, but when Bombay mace is present a red turbidity is obtained. The reaction given by tumeric is similar, but it may be distinguished from that of Bombay mace in the following manner: A strip of filter paper is saturated with the alcoholic solution, the excess of fluid removed, and the strips drawn through a cold, saturated solution of boric acid. When Bombay mace is present the paper remains unchanged, but in the presence of tumeric it turns orange brown. If a drop of potassium-hydrate solution is now placed on the strip of paper, it causes a blue ring if tumeric be present, and a red ring if the adulterant is Bombay mace.

The myristica argentea produces a dirty-brown colored mace, and the arillus generally consists of four broad stripes which are united above and below. In selecting mace care should be taken to select the orange-colored with a transparent-like appearance. When it has a tendency to crumble to dust it is considered of poor quality. Dull-looking parcels should be avoided, as such is never genuine mace, but is obtained from concrete virtue or expressed oil of bruised or broken nutmegs.

Although pure mace has a flavor quite similar to that of the nutmeg, it has a peculiarity of its own which most people prefer. It is extensively used for medicinal purposes.

Ground mace, which is powdered by stamps or by pounding, the same as nutmegs or mustard, loses its flavor very rapidly and when distilled yields a reddish,

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* Pharmacographia Indica.

buttery oil, which can be obtained by process of distillation. This oil is strong and volatile and contains an oxygenated body, the properties of which have not been determined. This buttery oil, mixed with other substances, is known as nutmeg balsam. (See nutmegs.)

The uniform, small-celled, angular parenchyma of mace contains numerous brown cells of large size and the inner parts contain thin, brown vascular bundles. The cells of the epidermis on either side are colorless, containing thick walls, longitudinally extended, and covered with a peculiar cuticle of broad, flat, ribbon-like cells as a continuous film which cannot be removed. The parenchyma also contains many small granules to which a red color is imparted by means of a solution of meracious nitrate and an orange hue by use of iodine. This result shows that they consist of albuminous matter without starch.

The chemical characteristics are so marked and the structure is so closely carried out that the adulteration of ground mace is very easily detected.

All the details of structure in the ground powder of mace are readily made out by chloral-hydrate preparation with the polarized light, as the brown vascular bundles, the ribbon-like and epidermal cells are all polarizing substances, while the large mass of granular parenchymous cells are not. The ribbon-like cells are particularly interesting in the varied forms they assume.

THE CHEMICAL COMPOSITION OF MACE

The nature of the principal constituent of mace can be found from the following experiments:

Seventeen grammes of finely pulverized mace were entirely exhausted by boiling ether and the solvent left to spontaneous evaporations. The residue, amounting to 5.57 grammes after dessications at 100 degrees C., was reduced in weight to 4.17, the loss 1.40 grammes being the essential oil, which was 8.2 per cent. The residue, amounting to 24.5 per cent., was thick, aromatic balsam in which we can find no trace or presence of fat, but, instead, it consisted of resin and semi-resinified aromatic oil. Alcohol extracts from this 1.4 per cent.

of uncrystallizable sugar, which may be reduced by cupric oxide. The drug after this treatment with alcohol and ether yields scarcely anything to cold water, but boiling water extracts 1.8 per cent. of mucilage, which takes a blue color if treated with iodine, or a reddish-violet if previously dried. This test shows that it has qualities quite different from those of nutmegs. This substance is not soluble in an ammoniacal solution of cupric oxide; it seems rather to be an intermediary body between gum and starch, and may be called amylodextrin.* It is distinguished from the true starch by being stained reddish brown instead of blue by an aqueous solution of iodine; the grains of amylodextrin* do not appear to contain even a nucleus of starch. As seen under the microscope, they have usually somewhat the form of a rod and are often curved or coiled; less often they are roundish or disc-shaped; they do not usually exhibit any evident stratification.

Chemical composition:

Water,	5.67	Undetermined,	41.17
Ash,	4.10	Crude Fiber,	8.93
Volatile Oil,	4.04	Albuminoids,	4.55
Resin,	27.50	Nitrogen,	.73

The city of Macassar, Celebes, exported during the first nine months of the year 1905, $4,520.61 worth of mace; and Padang, Sumatra, exported $1,617.17 during the same time. The city of Singapore exported $22,-710.12 worth during the year 1904.

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* Amyloceous, starchy.

MUSTARD

1 Flowering stem with leaves
2 Flower
3 Pod
4 Yellow seed
5 Black seed

CHAPTER XIV

MUSTARD

You are an appetizer prime,
And a friend in time of pain.
What did they do without you, pray,
Before Old Lady Clements' time?

FRENCH, *Moutarde;* German, *Senf;* Portuguese, *Mustarda;* Spanish, *Maszaza.*

The mustard of commerce is the seed, whole or powdered, of the several species of the genus brassica (or sinapis) of the mustard family. They are (cruciferous) plants which grow wild, or cinnamon charlock, and are cultivated under various conditions.

Mustard dates back through a number of centuries, and the mustard tree, spoken of in Luke XIII, 19, which attains a height of ten or even fifteen feet in Palestine, was probably the true mustard, brassica (sinapis) nigra, according to Ragle and others. The tree meant is Salvadora Persica, a small tree bearing minute berries with pungent seeds which bear the name in Arabic of mustard. Hippocrates used it in medicine under the name of vanuit.

In the time of Queen Elizabeth, the Dutch were employed to throw out the earth from the eighty-foot dyke to drain the farms of Lincolnshire, Norfolk, and Cambridgeshire, which were covered with water and had been the habitation of wild fowls. This dirt was found to contain small brown seeds which, on being exposed to the sun and air, sprouted and grew into plants, producing a yellow blossom which proved to be mustard.

The two common varieties are the black or brown mustard, known as (brassica sinapis nigra), and the white seed, as it is called, although of a yellow color (brassica sinapis alba), usually found in whole mixed spices. The Indian wild brown mustard seed (rai or

charlock juncea Sarepta brassica), taking the name Sarepta from the city of that name in Russia, in the government of Saratov, is sometimes offered as the black mustard. Sinapis glauca and sinapis ramosa yield a white seed found in South Russia and in the steppes northeast of the Caspian Sea. Mustard is known by every farmer and is an annual herb (see illustration), from three to six feet high, with lyrate leaves, yellowish flower, and slender pods containing round seed; it may be grown almost anywhere.

As only a few kinds of mustard seed are known to commerce, we will confine our history principally to the black seed, which is yellow within (brassica nigra), and which furnishes the most aroma. The seeds are very small and do not weigh more than one-fiftieth of a grain, while the seed of brassica alba, or the white seed, as it is called, is three times as large as the black.

Mustard seed is found in almost all of Europe, except the most northern part, in Northern Africa, Asia Minor, the United States, Mesapotamia, the West Indies, South Siberia, and China. It is naturalized in North and South America, and is cultivated to a great extent in Bohemia, Holland, and Italy, and in Lincolnshire and Yorkshire, England. It is generally put up for market in bags of 200 pounds each. Much of the black seed (Fig. 5) comes from California, and is brought to the Eastern market by railroads; much comes also from Kentucky. Each of these States produce large crops, and the New York Spice Mills use large quantities of it on account of its being cheaper than the imported. It does not contain as much flour as the yellow seed, but it is sweeter. The best dark seed comes from Italy and is exported from the city of Trieste, Austria, and is called Trieste mustard. (See illustration.) It is often sent by the Mediterranean Sea to London, and from there is transferred to New York vessels, although some comes direct from Bombay and Sicily.

The yellow or large, plump, straw-colored, rough, hairy seed (Fig. 5) is much less remunerative than the black, smooth seed; is white inside, and, though a native

TRIESTE, AUSTRIA

of Asia, is found in Russia and Africa. The best of it comes from England, and is often called English mustard.

The Dutch seed is considered next grade in quality to the English. In China and some parts of Europe a species is cultivated for greens for the table, which are prepared in the same way as spinach.

The great aim of the grower is to produce reddish-brown seed, without any intermixture of gray. The gray color of the seed is attributed to the influence of the rains during the ripening. The presence of this color greatly lowers the value of the seed.

The crop requires very little tillage. The seed is sown broadcast, in the month of April, at the rate of one bushel to an acre. The harvesting will take place in June and July. The land is sufficiently seeded to produce two crops, which are sometimes gathered in one year. A yield of forty bushels to an acre is not uncommon. The seed weighs sixty pounds to the bushel.

Mustard was first introduced as a table condiment in the year 1720 by an old lady named Clements, residing in Durham. It is from this fact that the well-known Durham mustard takes its name. She prepared it in a crude form by grinding the seed in a small hand mill. The product was nothing more than the crushed seed. This was passed through mesh sieves to separate the bran from the husk. The secret of this process she kept for many years.

Mustard was used as a medicine by the ancients and is spoken of in history by Theophrastus and Galen and others. Its use as a condiment is spoken of by Shakespeare in "Taming of the Shrew," Act IV, Scene III. The mustard which was made in the time of King George, who gave it his approval, was made from the wild charlock S. arvensis and was prepared by Lady Clements.

But as manufacturing gradually developed, in order to cater to public taste, the seed meal has been changed to the genuine mustard of to-day, which is the farina or flour of the black or white mustard seed, made from

the interior of the seed, which is separated from the outer coat or shell.

Mustard seed contains so much oil that it cannot be ground on common burr stones. It is prepared for market by first passing it through a winnowing machine to remove the dust and any other foreign material; it is next crushed by passing it between rollers; then it is placed in silk bags made for that purpose, and the volatile oil is extracted by hydraulic pressure. After the cake is dried it is put into pots and is stamped or pounded by a system of battery pounding, or by means of roller mills, in which the pounders vary in number from two to four, eight, twelve, or sixteen. The pounding or stamping continues until the cake is reduced to the consistency of soft middlings, or to the required powder. It is next scooped out into a trough and more cake is put into the pots. The stamping continues until all the cake is used up. Then it is scooped for bolting on sieves made of silk cloth of fine or coarse mesh, as required, which are set in frames and given a shaking motion by an upright shaft, the meal falling into a receptacle below. The quality of powdered mustard varies much, according to the quality of the mustard seed. Prime seed yields 50 to 60 per cent. of flour, and poor seed will run as low as 28 per cent. It does not pay to prepare poor seed, as the time lost in its preparation would not make up for the cheapness of it.

The operation of properly reducing mustard seed requires expert handling, and it can easily be ruined by incompetent operators. More than 50 or 60 per cent. of meal might be taken out at the first sifting, but to do so the bran would have to be chopped up so fine that some would pass through the sieve and spoil the appearance of the flour. The flour which is taken out at the first sifting is called superfine. If no more could be obtained from the seed than the superfine flour, it is very clear that the mustard flour would cost nearly or quite twice as much as the cake, with all the labor added. But to save this extra cost the miller often adds to the remaining bran or tailings an equal quantity of good wheat flour, and also 1 per cent. of good Cayenne pep-

per, and sufficient color (tumeric) to give the same tinge as that of pure mustard. Pound this as before and by the same process, the flour remaining is separated from the bran and united with the wheat flour. In passing through the sieve, 75 per cent. of the compound may be extracted. This product, which is better than most of the adulterated, is called fine. Nearly all of the wheat flour will pass through the sieves, and about 25 per cent. of the mustard and this 25 per cent. of bran is treated as before. As the wheat flour is increased, the hulls or bran will be less apt to affect the appearance of the mustard. This is called seconds. It is admitted that much of the good property of the mustard is in the bran, and, after all, it is only necessary to extract it to satisfy a popular prejudice as to what a fine, yellow color pure mustard ought to have. This notion is often wrong, just as coloring butter to please the eyes is wrong. These mixtures may all be mixed and powdered together, if rightly colored, and again bolted to make various grades, or, with experience in the use of a mill and an acquaintance with the nature of the particular kind of seed or the quality of the pressed cake, it may be powdered from the start, if sufficient adulteration is added to the cake. Thus a grade combining all the qualities may be made at one operation. This process reduces the labor to a minimum. After the sifting is completed there will remain a residue in the sieves, which is called dressing. This is used in wet mustard or French mustard, as it is known to the consumer. It is sometimes used by pickle manufacturers.

WET MUSTARD OR FRENCH MUSTARD

Consists of a compound of crushed mustard seed and vinegar, the seed having been passed between rollers and then washed into a cask or vat. With it there is often mixed garlic and such spice or flavoring material as the fancy or experience of the manufacturer will determine. This compound is ground two or three times through a stone mill or through a line of several mills, the material being fed from one to the other until it is received in a final reservoir, from which it is put

up in bottles. It is of a consistency of paste, which contains all the mustard, the oil, the flour, and the bran. It may be compounded with an indefinite variety of material, and the refuse bran of dry mustard may also be added. Its use is steadily increasing, and a very satisfactory article may be made at home by thoroughly pounding the seed and mixing it with good vinegar. In this way the maker can be sure that his compound has the virtue of purity and also of cheapness.

As the fixed oil has no pungency or mustard taste, it adds nothing to the flavor of the flour, but, instead, injures its keeping qualities, and, if left in, makes the seed very difficult to be pulverized. It is used as a salad and there is a ready market for it, as there is a great demand for it by the Jewish people.

Since hydraulic presses are expensive, costing from $2,000 to $4,000 each, but a small number of the spice millers press their own mustard seed. They either buy the mustard cake, which has been prepared by special mustard mills, or buy the pure or adulterated flour, already prepared for the market.

Some spice millers are suspicious of the cake, fearing it may be adulterated or be made up of partially poor seed, or of the refuse of previous workings, and they have good reasons for their fears, as such adulteration might occur, but as the pure article is to be judged by the flavor and pungency it may possess, it is as easy to test the cake as the seed.

Mustard is not only very popular as a condiment but is a medicinal rubefacient, as it has many stimulating properties. The use of mustard plasters every household is familiar with; mustard also promotes digestion, and it is a splendid emetic in case of poisoning.

A good story is told of a quack doctor who advertised electric belts for sale. He had received many testimonials from those who had bought them, his patrons speaking very highly of the benefit they had received from their use, but as the belts became worn and were ripped open it was found that the electricity they contained was made up of mustard flour.

In the ground mustard or mustard meal, as has been

explained, we have only the interior of the seed, with the exception of the few small portions of the husk, which may have escaped in the operation of bolting. The presence of these fragments enables us to recognize the source from which the flour is derived, and also to detect the use of mustard hulls as an adulterant of other food materials.

The farina or black and white mustard differs but little in appearance. The brown, however, is slightly darker. The outer colorous epidermis consists of angular plates, or hexagonal tabular cells, with a center of different brilliancy. It swells up and becomes slimy in water, and, therefore, must be observed in glycerine. At the best it requires some manipulation to see it well, and it is far less prominent in the black seed.

The next coat, denominated the subepidermal, is not prominent and can only be seen at all easily in the white seed.

The third layer is an important one, and in it is found the coloring matter of the brown seed. Its absence is the cause of the lack of color in the white variety. By this layer one is able to tell whether the flour is a mixture of both the black and white seed or if it is derived from one only. Fragments of this layer are common in powdered mustard. It is distinguished by the thick or colorless brown cell walls and their irregular dotted appearance. Between the third and second layers are numerous cells containing some color in the brown seed, but of little importance. Within these comes the important layer, denominated the inner tunic or plasma layer. It separates readily from the other parts of the husk and is often found by itself in the powdered mustard. As its contents are broken up by water or chloral-hydrate, it is necessary to use glycerine or oil in mounting.

The cells and their contents of this layer are large and much alike in both the black and white seed. The interior of the mustard seed is made up of small, soft parenchyma cells, containing the oil and the other constituents of the mustard, but without any trace of starch — a fact which makes adulterations easily detected.

The peculiar pungency and odor of the black seed are due to an essential or fixed oil, myronic acid, which is developed by the action of cold water (hot water will not answer) on two peculiar chemical substances which it contains, which form a compound, termed by the discoverers myronate of potash, but since called synanthrin, an acid with formula $C_{10}H_{19}NS_2O_{10}$. This acid is converted into the volatile oil of mustard or sulphocyanide of allyl C_4H_5NS, or $\left.\begin{matrix}C\\C_3H_5\end{matrix}\right\}\begin{matrix}N\\S\end{matrix}$. Through the agency of the myrosin, another constituent of brown seed, when the two are brought in contact through the medium of water, we have vegetable albumen, a bitter principle, a little gum and sugar, and a peculiar green substance, cellulose, and mineral water, called sulphocyanide of sinapine.* The aqueous extract of yellow mustard seed yields with a solution of ferric chloride a deep, blood-red coloration, which is scarcely perceptible with similar extract of black mustard. The aqueous extract of white mustard acquires a powerful odor of sulphurated hydrogen in a few hours, while that of the black seed smells only of the pungent mustard oil.

White mustard seed contains from 25 per cent. to 35 per cent. of an inodorous fixed oil with a little tendency to become rancid and of little pungency, which it will not give up in water. In place of myronic acid converted into volatile oil of mustard, it contains a non-volatile, bitter and acrid salt termed sulphocyanide of sinapine ($C_{17}H_{24}N_2SO_5$ or $C_{16}H_{23}NO_5CNHS$), myrosin gum cellulose and mineral matter. Now, as it is on the volatile oil and the acrid and somewhat bitter salt that the pungency and acridity of mustard depend, we can see a strong reason why in the mustard of commerce the farina of the two species, black and white seed, should be blended together, in the proportion of two parts of white to one of black. The black seed does contain some of the acrid principle as well as the volatile oil, as has been verified by the action of nitric acid, caustic potash, and ferric chloride, on the alcoholic extract. It is, therefore, the most valuable of the two seeds on

* Sinapaline sincaline.

account of the little volatile oil in the yellow seed. The acrid principle of white mustard appears to possess but little stability, although it has been said to bear a temperature of 130 degrees C. We find that it is readily affected by heat and that it is not safe to evaporate the alcoholic solution containing it at a higher temperature than about 30 degrees C., for, if subjected to a much higher temperature, it quickly loses its acridity and acquires a bitter, caramel-like taste.

The oil extracted by ether from the brown seed is of a bright and beautiful emerald-green color, owing to the peculiar green principle described as one of its constituents. So deep and remarkable is the color of the oil that it would be easy by means of a graduated scale of tints to determine with very tolerable certainty the percentage of brown mustard contained in any sample of mixed mustard. Specific gravity, 1.017; boils at 148 degrees.

Myronate of potash decomposes under the influence of the nitrogenous matter contained in brown mustard into volatile oil, glucose, and acid sulphate of potash. The quantity of each of these products of decomposition gives, therefore, by simple calculation, the quantity of myronic acid; one hundred parts of this acid yield 23.85 parts of volatile oil.

Place forty to fifty grammes of mustard farina in a flask of about one-half liter capacity; 250 cubic centimeters of tepid water should be poured over it, then close the flask with a cork and shake well. After twenty-four hours' standing connect the flask with a Liebig's condenser and heat to boiling. Pour thirty cubic centimeters strong ammonia into the receiver, the end of the condenser being dipped below the surface of the liquid. Water and the volatile oil will pass over, the oil at first floating in the shape of oily drops on the surface of the liquid, which soon sinks to the bottom, especially when the liquid is gently agitated. When no more oil globules pass over, the distillation has finished. The receiver should be closed with a cork and allowed to stand twenty-four hours; at the end of this time all the oil will be dissolved and is now contained in the liquid in

the form of thiosinamine ($C_4H_8N_2$). This solution is evaporated on the water bath in a weighed platinum basin, the residue dried and weighed, and the quantity of thiosinamine obtained, minus one molecule of ammonia, represents the amount of volatile oil. To estimate the amount of myrosin or albumen and sulphocyanide of sinapine, the amount of nitrogen and sulphur in the mustard should first be obtained, the former by combustion with soda lime in the well-known manner, and the latter by deflagration of the mustard and oxidation of its sulphur in a mixture of nitrate of soda and carbonate of potash. First, dissolve the mass in water or diluted acid, and the sulphuric acid contained in the solution is estimated by means of chloride of barium, and, from this data the amount of the myrosin and of the sulphocyanide of sinapine, the acrid principle is calculated. As much sulphur and nitrogen are first deducted from the totals of these substances obtained as is contained in the quantity of myronic acid previously determined.

Next, the whole remaining sulphur, and as much of the nitrogen as is required, are estimated in the acrid principle, and, lastly, the surplus nitrogen is calculated into myrosin, which has the same formula as vegetable albumen. But now, having the amount of the acrid principle and of the myrosin, a further calculation has to be made, since myrosin contains about 1 per cent. of sulphur, and this can be deducted from the total acrid principle, a corresponding quantity of nitrogen being in turn calculated into myrosin.

Chemical composition of white mustard:

Moisture,	9.32	Albuminoids,	28.37
	with variations	Myrosin Albumin,	5.24
Fat,	25.56	Soluble Matter,	27.38
Cellulose,	10.52	Volatile Oil,	.006
Sulphur,	0.99	Ash,	4.57
Nitrogen,	4.54	Soluble,	0.55

Chemical composition of brown mustard seed:

Moisture,	8.52	Sulphur,	1.28
Fat,	25.54	Ash,	4.98
Cellulose,	9.01	Fixed Oil,	36.00
Albuminoids,	25.50	Volatile Oil,	0.473
Myrosin and Albumen,	5.24	Potassium Myronate,	1.692
Soluble Matter,	24.22	Soluble,	1.11
Nitrogen,	4.38	with some variations	

Mustard is, no doubt, adulterated more than any other of the condiments, unless it be black pepper. Tumeric is the great agent used to bring out the desired color in the adulteration, and Cayenne pepper is used to give it a tonic flavor. In fact, tumeric has been so extensively used in adulterating the mustard flour that many consumers have become so accustomed to it that, in judging the prepared mustard meal with the eye, they prefer it on account of its yellow color to the genuine mustard. It is claimed by some that tumeric is desirable in toning down the pungency of mustard and in adding to its keeping quality, but if it was too pungent more yellow seed might be used in place of an admixture. Tumeric is treated more as a constituent of the mustard than as a foreign substance — a fact which makes it appear almost a commercial necessity. This should not be allowed.

The natural color of a pure meal is grayish or ashen, more like that of corn meal, and accordingly corn meal is considered a very good article to use as an adulterant; turnip, radish, and rape seed, and broken crackers are also often used. They are mixed with mustard seed and milled with it to increase the bulk and obtain more value from the cake.

Tumeric, whose coloring matter is called curcumin, is a root containing starch. It resembles ginger and is ground in the same way as ginger. It is more generally used in preference to ocher or yellow earth. As mustard flour does not contain any starch, the fraudulent tumeric and starch are readily detected in the farina by the use of iodine and ammonia. Place a little of the suspected sample, which has been previously heated and afterwards allowed to cool, on a piece of glass and add the ammonia or iodine, when the brown coloring prin-

ciple of the tumeric will be brought out. It may also be detected by its action with borax or boric acid and Martin yellow (dinitronapthol) by the use of 95 per cent. of alcohol. If capsicum be present the test would best be observed by treating the dry mustard with strong alcohol by percolation, which would develop the peculiar pungency of the capsicum when concentrated. The microscope is the best aid to detect it. Wheat flour, if used to adulterate, contains but 1.2 to 2.1 per cent., and reduces the natural yellow color of mustard, which must then be toned up with tumeric or some other coloring matter.

In the discussion of the analysis of mustard seed we may add that the flour is fairly constant in its composition; water is present in small amounts, varying between 3 and 7 per cent.; ash varies between 4 and 6 per cent., and so foreign mineral matter is easily detected. Volatile oil is present in the seed in small amounts, varying from 2.06 in one to as little as 0.55 in another. Fixed oil is one of the most prominent constituents of the seed. It varies in amount from 31 to 37 per cent. Starch is entirely absent in the whole seed. Crude fiber varies, depending on the care and method of milling. The amount should not be more than 6 to 7 per cent. Albuminoids make up a large part of the seed, varying from 25 to 30 per cent. If they are below 20 per cent. this fact points to dilution with material poor in nitrogen. The undetermined matter consists of gum and some unidentified substances soluble in alcohol, whose estimation is of no particular value, as a means of detecting adulterations.

As a whole, for general reference, the following table may be used:

Water,	3	to 7	per cent.
Ash,	4	to 6	per cent.
Volatile Oil,	½	to 2	per cent.
Fixed Oil,	31	to 37	per cent., from entire seed
Fixed Oil,	16	to 18	per cent., from cake
Starch,	None		
Crude Fiber,	5	to 18	per cent.
Albuminoids,	25	to 32	per cent.

SAGE

1 Flower
2 Flower without stamens

CHAPTER XV

HERBS

NEARLY every one is familiar with the subject of this chapter. The sweet and aromatic herbs for culinary purposes are found in both hemispheres, and little, therefore, need be said about them. Of those who know them, none are better acquainted or more familiar with their use than the farmer's wife. The herbs we are to consider are the few having that peculiar property of imparting to fresh meats a flavor, so much esteemed, which brings them into general use. They are also used for medicinal purposes of which we have the following kinds: Sage, marjoram, savory, parsley, and thyme. "Herbs to still the summer." "The knowledge of stilling is one of pretty feat," but it is a lost art. The stilling room was also a drying room, and in breezy shadows throughout the long summer days were drying leaves and sprigs of many aromatic plants. The branches were often made up into small bunches, the size to be used for a kettle of soup or for the basting of a single roast. "These were the fagots of herbs so often ordered in old recipes, and were a not unimportant part of household supplies. There is no spice comparable for herbs use in rosemary." Pliny says that the serpents sought the shade of the fennel to strengthen their sight. Culpepper noted the starry influence under which each plant grew.

SAGE

Sage (*Salvia officinalis*) is the common sage. Sage, sauge, swage, natural order *Laminaceoe.*

French, *Sauge;* Portuguese, *Salva;* Italian and Latin, *Salvia, Salvas* (Culpepper). It is governed by Mars. Salvia, from salvo, to save or heal. The most extensively used of the herbs is the sage. Its high reputation as a medicine lasted for years. The Arabians valued it,

and the medical school of Salerno summed up its surpassing merits in the line, "*Cur morietor homo cui salvia cresit in horto?*" (How can a man die who grows sage in his garden?) Perhaps this originated the English saying, "Who eats sage in May shall live for aye." Parkinson says: "It maketh the hayre blacke, it is good for woundis. For lethargy and forgetfulness bathe the back of the head with a decoction of sage and smallage." Pepys notes that in churchyards between Gasport and Southampton, England, the custom prevailed of sowing the graves with sage. Evelyn sums up its noble properties by its assiduous use as making man immortal. "We cannot, therefore, but allow the tender summities of the young leaves but principally the flowers in our sallet."

Salvia officinalis and *S. grandiflora.* The first is the common garden sage, a native of southern Europe, and has been naturalized for many years in this country as a garden plant. It is a perennial shrub, seldom more than two feet high and sometimes treated as an annual. The plant has a pubescent four-sided stem with erect branches, hoary with down, and leafy at the base, those bearing flowers being about a foot or a foot and a half long. The flowers are in racemes of blue variegated with purple (rarely red), arranged in spiked whorls. The flowers have but two perfect stamens, the filaments of which bear at their summit a cross thread. A much-elongated connective is fastened by a point and has one cell of the anther at the upper end and the other, but imperfect, cell at the other end. The seeds of many species, when steeped in water, become covered with a mucilaginous slime, like that of quince seeds. The leaves are ovate, oblong, lanceolate, finely notched, are curiously wrinkled or rough, hairy or tomentose, and of a whitish-green color. The leaves and tops are gathered and dried during the flowering seasons, which is in June and July. Sage is slightly tonic with a peculiar, strong, astringent, aromatic, camphorous odor, and a sharp, warm, slightly bitter taste. These properties are owing to its volatile oil (sage oil), which may be obtained by distilling the plant with water infusion, but

MARJORAM

1 Leaf and flower stem
2 Bract of flower
3, 4 Different views of flower
5 Stamens
6 Seed

more especially in alcohol. Formerly it had a high reputation as a sudorific and as an antiseptic, and was so esteemed by the ancients, especially by the Chinese, but at present, though officinal, it is little used as a remedy except in domestic practice, and it has no place in the pharmacopœia. But the infusion is much valued in cases of gastric debility as a gargle, checking flatulency with speed and certainty. It is a good astringent and nerve tonic as well as a good remedy for use in cases of rheumatism. But its great use is as a condiment in flavoring dress, sausage, cheese, etc. Sage grows best in dry soil and is found growing on sunny mountain slopes and rocks. It has long been in general cultivation in gardens, and it is easily raised from the seed or from cuttings or divisions of the root. Roots should be planted about six inches apart. Sage brush (*Carteunissia hidenlata*) is found on Western table lands. The apple-bearing sage (*S. pomifera*) is a native of Southern Europe and is remarkable for its reddish or purple bracts and large gall nuts growing on the branches as on the leaves of the oak. These are known as sage apples. They have an agreeable aromatic taste and are edible. Both these species are used to adulterate.

The Salvia longiflora of Peru sometimes attains the height of twenty feet, with flowers six to eight inches long. Several kinds are found fifteen feet in height. There are said to be nearly 300 varieties of sage, among which are the following: S. splenden, with large spiked, scarlet flowers, from Mexico, which is esteemed by florists; S. coccinea, with smaller, but handsome flowers; the open-corolled S. patens, with tall, open spikes, with large blue flowers; the bracteated S. involucrata, with thick obtuse spikes of reddish-purple flowers; the Clory S. sclarea, with large, beautiful, purplish-green deciduous bracts.

MARJORAM

Marjoram (*Origanum marjorum*).

Origanum (meaning in Greek, joy of the mountains).

Sweet marjoram, a genus of the natural order of plants labiatœ or mint family. It is chiefly a native of Greece and the countries bordering on the Mediterranean. It is an annual shrubby plant with a stem about one foot high, and has a ten-ribbed, five-toothed calyx, loose spikes, and broad bracts. It is peculiarly aromatic and fragrant, and is much used, as other mint plants are used, in common cooking. It has nearly an entire ovate, or egg-shaped, grayish or green, leaf, covered on both sides with a thin down, situated about three roundish heads of small purplish flowers crowded in cylindrical or oblong spikes, which are imbricated with colored bracts. It flowers in August. The flowers are very small and inconspicuous. Marjoram contains a yellowish essential oil (oil of marjoram or oil of origanum), which is obtained from some species by distillation. It yields fifteen ounces from one hundred and fifty pounds of the recent-cut plants. This oil will become solid by standing. It is used for toothache and for cancers. An infusion of it is a stimulant and is a good remedy for nervousness. It is mixed with olive oil to make a stimulating liniment, which is used as a remedy for rheumatic complaints and for baldness, and in case of sprains and bruises. The common marjoram, wild (O. valgore), is found on dry hilly, bushy places.

PARSLEY

Parsley (*Carum petroselinum sativum*).

French, *Persil* (Culpepper). It is governed by Venus.

Parsley is a biennial plant, with a fleshy, spindle-shaped root and a rough, erect, smooth-branching stem. It is a native of the Eastern Mediterranean region. It is now widely cultivated in all parts of the civilized world as a culinary vegetable, and it sometimes runs wild, the root being one of the principal parts. It is a great favorite on account of its much-divided, finely cut, crisped, aromatic leaves, which are used in flavoring soups and other dishes and for garnishing. The leaves of the wild parsley are plain. Parsley has a white or greenish-yellow flower and from the seed an essential

PARSLEY

1 Ripening fruit
2 Ripening fruit, more developed
3 Flower
4 Stamen
5 Pistil
6 Seed

SAVORY

1 Flower
2 Flower without stamens
3 Leaf
4 Flower cut, showing stamens
5 Corolla
6 Leaves of an axil
7 Pistil
8 Stamen
9 Seed

oil is obtained, named apial, which is used as a drug in place of quinine in intermittent fevers. Its leaves are often chewed to neutralize the scent of onions. Parsley wreaths were twined for the victors of the Nemean games, but now it has fallen from its high estate to flavor or to garnish some lordly dish. The seed was formerly mixed in cheese curds with fennel and thyme and other fragrant herbs. The roots were also used as a relish, as noted in the words of Wynkyn, "de worde in the Boke of Keriynge says 'quinces and peres Ciryppe with parcelery rate. Bight to begyn your mele." Parsley seeds germinate imperfectly and the disappointment of the sower was explained by the belief that the devil took his tithe thereof. Many dire evils, belief in which can scarcely now be understood, were attached to the sowing, gathering, and even dreaming of parsley seed. These beliefs may have originated in the fact that the Greeks strewed it upon newly made graves. To be in need of parsley was a colloquialism which expressed the imminence of death. Herrick said: "Dear Perenna, Prithee come and with Smallage dress my tomb."

SAVORY

Satureia Hortensis, a genus of the natural order *labiatoe,* belonging to the mint family.

French, *Savorae.*

It is said to be governed by Mercury (Culpepper) and was supposed to belong to the satyrs. The summer savory is chiefly of two kinds — *S. Hortensis,* the summer savory, and *S. Montana,* the winter savory. Both kinds are natives of Southern Europe. Savory is mentioned in the Old Testament (Genesis, Chap. XXVII, 4th verse): "And make me savoury meet such as I love, and bring it to me that I may eat, that my soul may bless thee before I die." Savory was probably introduced into Britain by the Romans, as we find it spoken of in a Latin treatise, "Husbandric of Pallodius," at the fifteenth century, translated about 1420. It is a common herbaceous plant, from ten inches to one foot high, being half shrubby, with numerous stalks, which

are very hard and woody near the bottom. The leaves are narrow, oblong or linear or lanceolate, entire, acute at the end, with resinous dots and short axillary, standing two at each joint, with a quantity of young ones in their axils. The flowers, which grow on the upper part of the stalk among the leaves, are white with a tinge of blue or red. The whole plant of the common summer savory (*S. Hortensis*), as our cultivated garden herb is known, has an agreeable pungent taste and aromatic odor, and is analogous to those of thyme (*thymus*), differing from it in the regular five-toothed or fine-cleft calyx and having the stamens bent together into an arch under the upper lip of the corolla, both being in common use as a seasoning in cooking, either fresh or dried, for flavoring dishes, and especially for flavoring beans, and is cultivated for these culinary purposes in Europe and America. Its tea is used as a remedy for colic and as a cathartic. Winter savory (*S. Montana*) is used in the same way as the summer savory.

THYME

Garden thyme (*Thymus vulgaris*).

French, *Thym;* German, *Thyman.*

Thyme teucrium marum and Thyme pallium. It is a plant of the genus thymus, a humble, half-shrubby plant of the natural order labiatæ (mint family); Latin, thymus incense, thus indicating its former use on sacrificial altars. It is said to have made the bed in the stable at Bethlehem and was used in many charms and incantations. "It is ever the bee's alluring time," and it was wild thyme which gave the famed flavor to the honey of Mount Hymettus. Among the Greeks thyme denoted graceful elegance of the Attic style. To smell of thyme was an expression of praise applied to those whose style was admirable. In the days of chivalry, peradventure, very highly noted ladies used to embroider their knightly heroes' scarfs with the figure of a bee hovering about a sprig of thyme, the bees as the belles of thyme. Early lists of English plants give no name with which it can certainly be identified. It grows from six inches to one foot high and has a two-

THYME

1	Plant	6	Fruit
2	Root	7	Seed
3	Leaf	8	Stamen
4, 5	Stamens	9	Seed

lipped calyx and four diverging stamens and is clothed with a hoary down, with narrow, almost elliptical leaves with edges turned in. It may have many stems slightly indented in pairs, standing erect upon short petioles or decumbent at the base, which bear very small ovate leaves, which are sharp-pointed, while those of the whorls are blunt. The flowers are of a pale purple or whitish or reddish color, which grow in separate whorls, six in a whorl. It flowers from May until August and is a native of Europe and especially of Southern France. It is commonly found growing on dry hills and is cultivated in gardens on account of its fragrance. It has a pungent, aromatic property and is largely used as a seasoning for soups, sauces, etc. From it is also distilled the oil of thyme, which is considerably used in veterinary practice and for perfumery, and often passes as oil of organum. The tea of thyme is also used for nervous habits. The wild creeping thyme, or mother of thyme, is *T. serpillum,* a less erect plant which has a procumbent stem with many branches from two to three feet long, small entire oval leaves and purplish flowers, arranged in whorls, which are united in a dense terminal leafy head. This variety is abundant on hills and mountains in Great Britain and in all parts of Europe and the north of Asia, between forty and fifty varieties being described. It is less fragrant than garden thyme, but both species have the same aromatic essential oil.

T. serpillum has procumbent stems, numerous short ascending branches, ending in short, loose, leafy, whorled flower spikes, the leaves being egg-shaped and narrow and more or less fringed toward the bottom, those of the flower spikes being similar but smaller. There are two forms — *T. en serpillum,* with flowering branches, ascending from shoots, which are barren at the tip in one head, and the upper lip of the corolla oblong; and *T. chamoedrys,* in which all the branches ascend from the crown of the root stalk with whorls in many axillary heads and a short and broad upper lip to the corolla. The flowering branches, *herba thymi* and *herba serpylli,* are used in medicine as a powerful stimulant.

The lemon thyme, or lemon-seented thyme of our gardens, is regarded as a variety of thyme serpyllum known as *citratus* or *citriodrus,* which is generally a hardy and very dwarfed traveling evergreen, of lower growth than the common garden thyme. No species of thyme is indigenous in America. Seed should be sown in drills or broadcast in Mareh or April, in light, fine earth and raked in lightly. The young plants are transplanted in the summer when from two to three inches high. After they are from three to five ineches in growth, they should be thinned out to about ten inches apart. Thyme is also propagated by slips of the branching shoots in the spring or early autumn, but more especially by sections of the brush or by removing rooted branches.

The harvesting takes place in August by cutting the plants rather closely down with a very sharp sickle. The seed should be dried on cloth, rubbed out clean, and preserved in a dry plaee for sowing the following year. In using the herb for distillation it should not be dried, but the erop gathered each day should be put in the still at once.

SEED

In addition to the seed before mentioned which are used in conneetion with spices are the caraway, or *carum carui.*

Coriander or the dried fruit of the *Cariandrum salivum,* and the cardamom or the dried capsules of *Elettaria cardamomum.*

CARAWAY

Caraway (*Carum carui*).

The common name, caraway or carraway, is given to the dried fruits *carum carui,* which is a biennial umbelliferous plant. The English name caraway and the Spanish name alcarahuega are derived from the name given to the fruit by the Arabians, "karawya." It is a native of Great Britain, growing on very low ground with a root much like the parsnip. The seeds are sown in drills in the autumn soon after they are ripe, and

must be thinned out the same as carrots and other similar plants, and must be kept free from weeds. They will flower in June and are ready for harvesting in July. The plant grows two or three feet high. The leaves are long and subdivided into numerous pinnulæ or segments which are narrow-pointed and of a dark color. The flowers grow in terminal umbels. The seeds are two, naked, brown, striated, and of an oblong shape, hot and acrid but pleasant to the taste. The seed abounds in essential oil containing gummy and resinous parts. Its tincture is used as a stomachic and carminative. It is used as a flavoring in cooking.

CORIANDER

(*Kariandrum.*) The product known as coriander seed consists of the dried ripe fruit of cariandrum salivum, which is the only specie of the genus umbelliferœ. It is an annual herb cultivated in France and Germany for its seed. It grows about two feet high with branching stems. The stalks are round and erect and hollow, but have a pith within. The leaves are bipinnate, the lower ones divided into broad or wedge-shaped, deeply cut segments, while the upper ones are divided into narrow parts and more finely cut. The flowers grow in clusters of a white or reddish color upon its branches. The umbels have five to eight rays without a general involucre and the partial ones consists of a few small bracts. The seeds follow, two after each flower. They are half round and are the only part of the plant used. The most characteristic feature is this globular fruit, which is of a chamois or pale-yellow color and is about the size of the white pepper corn, which is crowned by the teeth of the calyx and contains no oil channels on the outer surface, but has two on the inner face of each half of the fruit. The ridges are five in number and very indistinct. As the two carpels, of which the fruit is composed, do not readily separate one from the other, they being protected by the ligneous pericarp, the fruit must be broken before submitting them to distillation. The unripe fruit possesses the intensely disgusting odors of the other parts of the plant, and for that reason it

should be allowed to ripen fully before gathering. When they are dry they are sweet and fragrant. They dispel wind and warm and strengthen the stomach, and assist in digestion, and are good for pains in the head. They are also used in whole mixed spices, used for pickling.

CARDAMOM

Cardamom, Kardamom (*Amomum cardamomum*).

Cardamom is the fruit of various East India or Chinese plants of the genera elettari of the ginger family (*Zingiberaceoe*). Especially the most esteemed are those contained in the dried capsules, *E. cardamomum* of Malabar, which differs from the genus amomum by its elongated filiform tube of the corolla, by the presence of internal lateral lobes in the shape of very small tooth-like processes and by the filaments not being prolonged beyond the anther. All the species are natives of the tropical parts of India. Small or Malabar cardamoms, as they are known commercially, are the rhizomes which are thick, fleshy, or woody and ridged with scars of the attachments of previous leaves, giving off fibrous roots below. Stems, perennial, erect, smooth, jointed, enveloped in the spongy sheaths of the leaves, from six to nine feet high and about one inch thick, round and green and hollow, but with pith within, and resemble our reeds in many respects. The leaves are a half yard long, alternate, sessile in their sheath, entire lanceolate, fine-pointed, pubescent above, silky beneath, sheaths slightly villous with a roundish ligule rising from the mouth, and as broad as a man's hand. Besides these stalks, there rises from the same root others which are weak and tender and about eight inches high, which produce the flowers, which are small and greenish. Following every flower comes one of the fruits called the great cardamom, which is a light, dry, hollow fruit of a whitish color, and somewhat triangular in shape, and of the size of a small bean, and of a dry substance on the outside, but with several small seeds within, which are reddish in color and very acrid but pleasant to the taste. These fruits are called the lesser cardamoms or

cardamom seeds, and they are excellent to strengthen the stomach and to assist digestion. They also are good for disorders of the head and are equal to anything to be had for colics, and are best used by chewing. They are used in whole mixed spices. There are two other kinds of cardamoms known as the middle cardamom, a long fruit, seldom met with, and the great cardamom, generally called "Grain of Paradise."

In the home market three kinds of cardamoms are found under the curious names of "shorts," "short-longs," and "long-longs." Shorts are capsules from a quarter to half an inch long and a quarter of an inch broad, and the longest of the long-longs is about one inch in length.